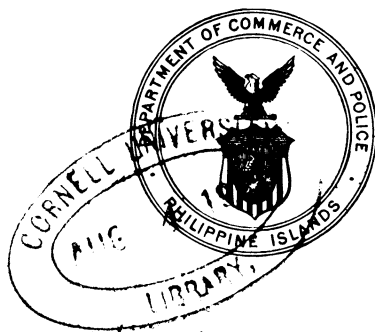




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# BUREAU OF PUBLIC WORKS



## Quarterly Bulletin

VOL. 4

APRIL 1, 1915

No. 1



Eighteen kilometers of the Baguio-Bauang Road, Union Province. Palali Hill, kilometer 30, to the China Sea.

# QUARTERLY BULLETIN

BUREAU OF PUBLIC WORKS  
MANILA, P. I.

ISSUED QUARTERLY BY  
THE CONSTRUCTING DIVISION, UNDER THE DIRECTION OF  
THE DIRECTOR OF PUBLIC WORKS

C. A. TANSILL, COMPILER OF STATISTICS

The objects of the QUARTERLY BULLETIN are:

1. To show each engineer and employee of the Bureau of Public Works the work of the Bureau as a unit.
2. To show him that his work is a unit part of the whole.
3. To make clear to every provincial and municipal official and to the people the work being done by the Bureau.
4. To make the work of the Bureau of personal interest to all.

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## THE BENGUET AND NAGUILIAN ROADS.

By WARWICK GREENE.

Convinced of the imperative need of a highway into Baguio cheaper to maintain and more reliable for traffic than the Benguet Road, in October, 1913, I recommended to Governor-General Harrison the construction of a so-called "Naguilian Road" into Baguio.

At that time there existed a narrow cart road over the greater portion of this route, passable by light automobiles during the dry season, but incapable of sustaining heavy traffic of any kind. Its construction had been due largely to the enthusiasm of the Mountain Province officials and their belief that it would be the ultimate highway route into Baguio.

A short section—from the coast at Bauang to Naguilian—had been constructed as a first-class road by the district engineer of La Union.

I recommended that a first-class road be constructed from the sea at Bauang to Baguio, that the same be used as the principal means of communication with Baguio pending the completion of the railroad, and that the Benguet Road be maintained as a dry-weather road to Baguio as long as its maintenance was cheap and until it suffered another of its periodical rainy-season "smash ups" when it could be finally abandoned.

A committee of two, Commissioners Singson and De Veyra, were appointed to investigate and report on the matter to the Commission. Upon receipt of their favorable recommendation, money was appropriated (Act No. 2312, dated January 15, 1914) and the project

commenced. With the exception of permanent bridges over the Ripsuan and Naguilian Rivers, the road was finished early in April, 1915. The total cost of the highway project from Bauang on the sea-coast to Baguio, 50 kilometers (31 miles) has been less than ₱640,000 (\$320,000 U. S. currency), including the work previously done under the supervision of the Mountain Province officials. The construction of steel bridges at Naguilian and Ripsuan will bring the ultimate complete cost to a little less than ₱1,000,000 (\$500,000 U. S. currency).

The Benguet Road cost ₱4,000,000 (\$2,000,000 U. S. currency) to build, and up to January 1, 1915, had cost ₱1,818,000 (\$909,000 U. S. currency) for improvements and maintenance, including restoration after heavy floods.

The length of the Benguet Road as first constructed was about 45 kilometers (27.9 miles); as maintained after construction of the railroad to Camp One and the incorporation of part of the Benguet Road in the first-class road system of the Province of Pangasinan, a little over 33 kilometers (20.5 miles).

The cost of maintenance has been greatly reduced during the past year and a half, due principally to the light rainy season of 1914, but also due to the fact that we are allowing the bridges to deteriorate and are making only provisional repairs on the same, and to the unusual skill of Mr. Williams, the district engineer at Baguio, who has been in charge of the road during that time.

The maintenance of the new road will be much less than that of the Benguet Road, mainly because it follows a ridge location, and the Benguet a cañon location. For the greater part of its distance the Benguet Road lies at the bottom of a deep gorge, subject to the discharge from a watershed that in some places reaches a maximum elevation of 6,000 feet above the road. These mountain sides are sparsely covered with vegetation, are exceedingly steep, are composed of disintegrated and friable materials and shattered formations, and are subject to extraordinary rainfalls, running as high as 46 inches in twenty-four hours.<sup>1</sup>

On the other hand, the Naguilian Road is located near the summit of the hillside and ridges that it follows, and consequently will be subject to the rainfall discharge from a very limited watershed. The excessive number of bridges necessary on the Benguet Road, with their high cost of maintenance, are also eliminated. For these reasons the Naguilian Road will be cheaper to maintain and will be closed to traffic for much shorter periods during the rainy season than has been the case with the Benguet Road.

It will not do, however, to underestimate the cost, difficulties, and dangers of the maintenance of the new road. It is located in the same mountainous country of unstable geological formation and excessive rainfall as the old road. It will be subject to many slides and extensive washouts when heavy typhoons, with their enormous precipitation of rain, strike the Benguet Mountains. There is even a remote danger that in places the ridge itself, on which the road is located, may break down under the effect of these storms, although this is not likely to happen. But Baguio must have a highway connection and the Naguilian Road is the cheapest and most feasible route under any conditions that are likely to arise.

The only advantage the Benguet Road enjoys over its rival is the shorter distance (by rail and road) from Baguio to Manila, about 40 kilometers (24.8 miles).

Not only does the Naguilian Road possess all the advantages already enumerated, but it also connects Baguio with the seaport San Fernando. By the construction of port works this can be developed into the principal port for the entire Ilocano country and the port of entry for Baguio as it develops into one of the health resorts of the Far East.

The total amount appropriated by the Commission since October, 1913, for construction of the section of the road that lies in the Mountain Province is ₱295,000. Furthermore, the Commission has appropriated ₱52,000 (Act No. 2440, January 5, 1915) for the maintenance of the 35-kilometer section in the Mountain Province.

Under the able management of Mr. Williams, the engineer in charge of the road, its cost of construction has been low; supervision and "overhead" charges have also been reduced to the minimum.

<sup>1</sup> See report of Rev. José Algue, S. J., Weather Bulletin for July, 1911.

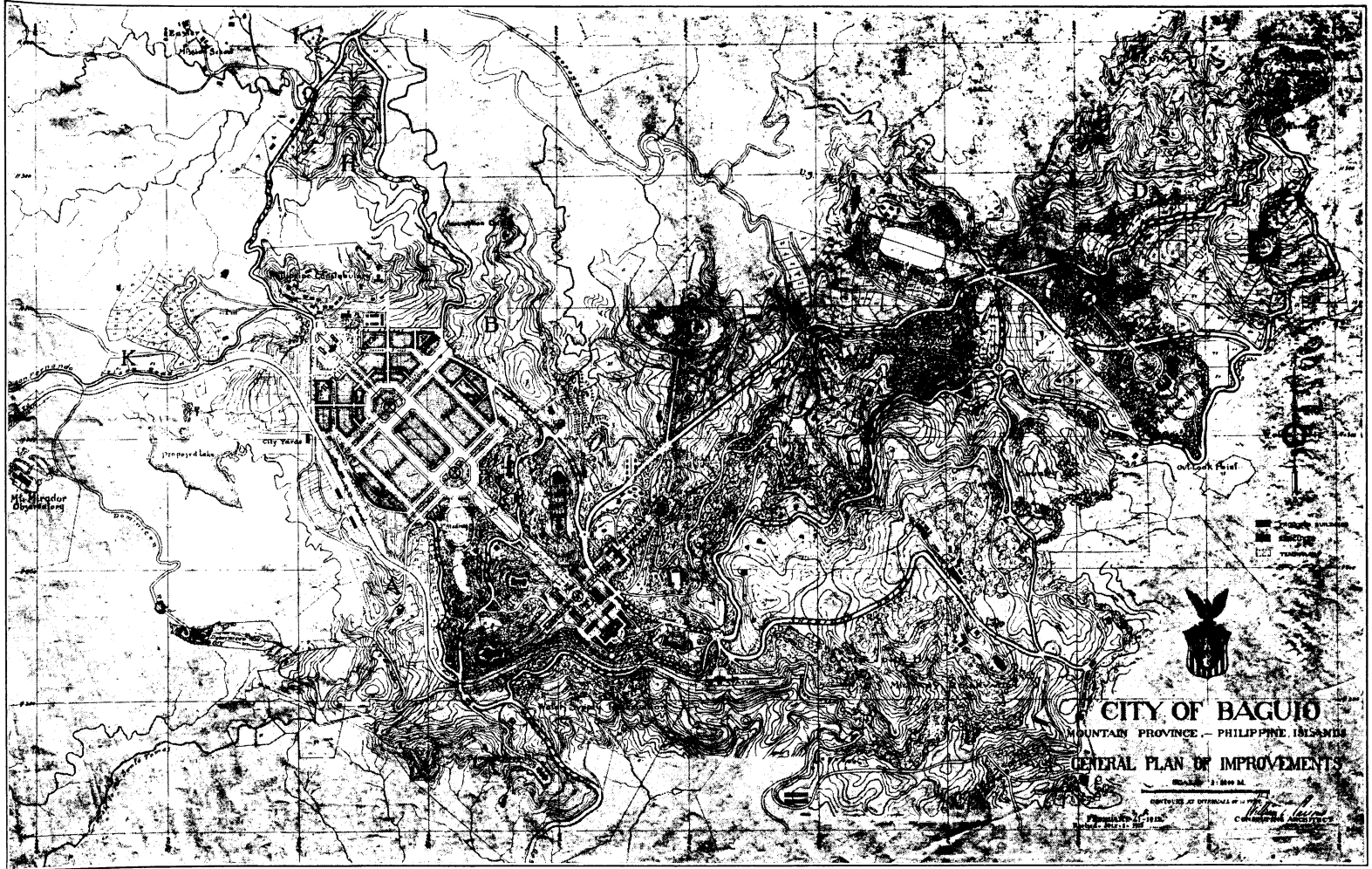
## THE BAGUIO-BAUANG ROAD.

By A. D. WILLIAMS, Civil Engineer.

[See title-page (Palali Hill to China Sea). 18 kilometers of road.]

The Baguio-Bauang Road provides another outlet for Baguio to the coast, connecting with the present terminus of the Manila Railway Company's line north and affording direct communication to the port of San Fernando, 10 kilometers north of Bauang, as shown on the accompanying map. The importance of constructing a highway to Baguio to replace the famous Benguet Road and its costly and difficult maintenance problems had been under consideration for a number of years and in July, 1911, the necessity became apparent. The Benguet Road was visited by the most disastrous flood in its history and the damage to the roadbed and structures was estimated at approximately ₱1,000,000. The road was closed to all classes of traffic

ing cars over it during the dry season. Work was also completed during 1912 on the construction of a first-class road between the towns of Bauang and Naguilian, La Union, a distance of 8 kilometers, replacing an old Spanish road which formerly connected these towns. This road is now a section of the present Baguio-Bauang Road. The construction of 8 kilometers of first-class road from Naguilian to Barrio Ribsuan, replacing the section of the old Naguilian Trail in La Union Province, was undertaken and completed during 1913. The city of Baguio during the same year converted the section of the old trail within the city limits into 8 kilometers of second-class road, leaving a 28-kilometer section of cart trail in the subprovince of Benguet to be improved. An appropriation for the construction and reconstruction of this portion of the road was made on January 15, 1914. Grading work was completed December 23, 1914, and the surfacing of the road, March 25, 1915, converting the whole Baguio-



for a period of about two months and it required about five months and an expenditure of ₱50,000 to open the road for through traffic. Investigations and surveys were begun at this time to determine a more feasible location for a road from the coast to Baguio, and, while definite plans were not arrived at for constructing such a road, it marks the beginning of the project here described. The old Spanish horse trail from Naguilian, La Union Province, to Baguio, known as the Naguilian Trail, which had been improved upon since the early days of American occupation, was further improved by widening and reducing gradients, making it into a cart trail passable with difficulty for teams. This trail had been the only way of reaching Baguio from the west coast until the Benguet Road was constructed and it was the only means of handling traffic to and from Baguio during the period that the Benguet Road was closed in 1911 and again in the rainy season of 1912, when traffic was interrupted for a short period over the Benguet Road. The trail was improved to such an extent during the years 1911 and 1912 that it was possible to take small tour-

Bauang Road into a first-class road with the exception of the temporary sections of road at the Ribsuan and Naguilian River crossings where collapsible bridges are used. The distance from Baguio to Bauang over the new road is 50 kilometers and to San Fernando, the capital of La Union Province and an important seaport for the Ilocos and Mountain Provinces, 60 kilometers. The municipality of Naguilian on the Baguio-Bauang Road is the richest municipality in La Union, with a population of 12,000 people. This municipality ranks next to the Cagayan Valley in the production of high-grade tobacco and the new road has given such an impetus to agricultural development in general that fully 50 per cent more land is now under cultivation.

The improvement of the port of San Fernando has been investigated for a number of years and several schemes are proposed for converting this port into a safe harbor for vessels at all times of the year. The estimated cost of the proposed improvements range from ₱1,000,000 to ₱2,000,000 and while the commerce of the port has

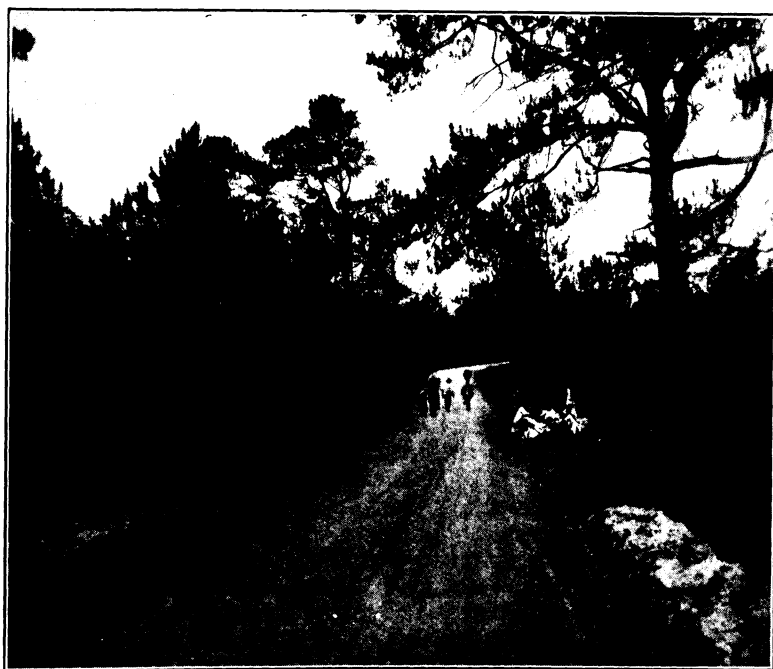
not warranted the expenditure up to the present time, the increased importance of the port with the completion of the Baguio-Bauang Road, affording direct communication to Baguio and the Mountain Province, will no doubt warrant the undertaking in the near future. It is also proposed to extend the railroad line to San Fernando



Camp Quioeng, Baguio-Naguilian Road, Mountain Province.

within the next two years, which will give additional importance to the town as the most important commercial center in the Ilocos Provinces. The population of the town at the present time is 16,000.

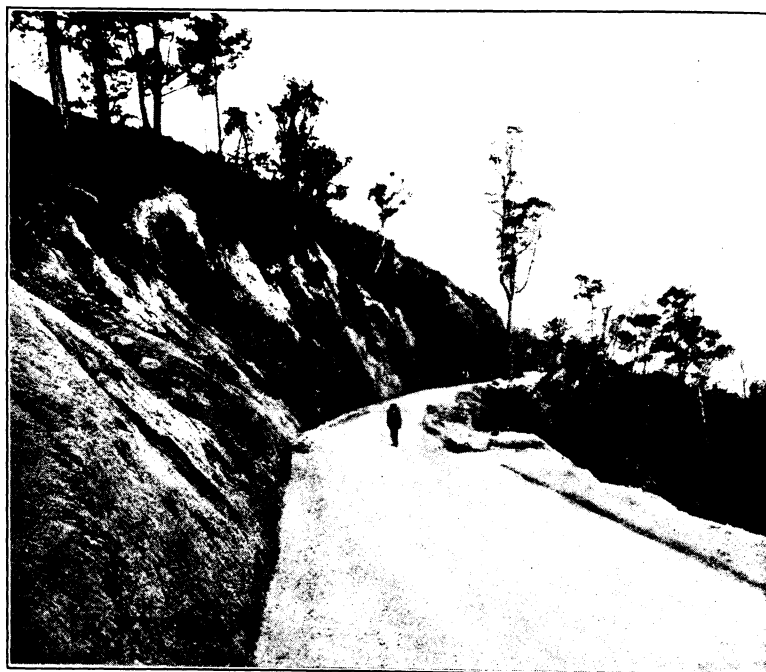
The advantages of the Baguio-Bauang Road over the Benguet Road to Baguio—the health resort of the Philippines and destined to be the principal health resort of the Orient—aside from probable maintenance difficulties and cost is that it provides a shorter route to the main line of railroad and an outlet to a seaport. With the



Kilometer 6, Baguio-Naguilian Road, Mountain Province.

traffic interruptions and maintenance difficulties that have been contended with on the Benguet Road, it is now an easy matter to criticize the location of the road as an error, at the same time allowance should be made for conditions obtaining at the time the project was undertaken and the fact that the engineers responsible

for the location and construction had had but meager experience in road work under Philippine conditions. The terminus of the Manila Railroad Company's north line was at Dagupan and a road following up the Bued River was the most direct and the distance from the railroad and to Manila shorter than by any route from the west. It was also probable at this time that the feasible location for a railroad to Baguio would follow the route of the Benguet Road, and the construction of a branch line from Dagupan to Camp One was completed soon after the construction of the road. This line, however, represented very temporary construction and proved difficult to maintain and was later used only during the dry season until it was abandoned about a year ago. With trains running to Camp One Baguio was 34 kilometers from the railroad, instead of 84 kilometers to Dagupan. Railroad transportation for Baguio will, however, be solved with the completion of the Aringay-Baguio branch line which is under construction. While the cost and difficulties that may be encountered in the maintenance of the Baguio-Bauang road are somewhat problematical, it is reasonable to suppose that the cost of maintenance will compare favorably with other mountain roads subjected to the same weather and traffic conditions, and that it will be possible to keep the road open to traffic at all times of the year excepting short interrup-



Kilometer 8, Baguio-Naguilian Road, Mountain Province.

tions in the rainy season when slides may be expected until the slopes have weathered flat enough to stand.

With the proposed transfer of heavy traffic to Baguio from the Benguet Road to the new road the future of the Benguet Road will probably depend on the cost of its maintenance for light traffic. Act No. 2414 of the Philippine Commission declared that portion of the Benguet Road within the Mountain Province a toll road and authorized the collection of tolls on all classes of traffic, excepting vehicles, etc., of the Army, Navy, and Philippine Constabulary, beginning November 25, 1914, and the use of tolls collected for the maintenance and repair of the road. The road has been maintained from toll receipts since January 1, 1915, and it is very possible that toll collections will be sufficient to keep the road open for light traffic during the dry season for several years. The present importance of the Benguet Road in connection with the Baguio-Bauang Road concerns not only Baguio as a part of a highway from this city to Manila, but the Ilocos Provinces as a connecting link in the Manila-North Road now in condition for any class of traffic via Baguio from Manila to Bangui, Ilocos Norte Province.

The lowland section of the road represents for the most part a new location. The road between Bauang and Naguilian replaces an old Spanish road between these towns, which was practically for

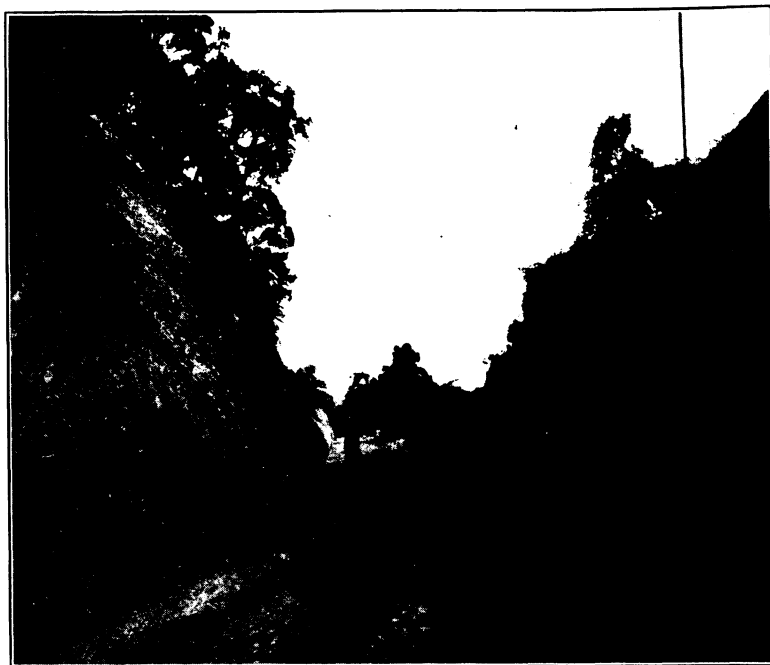
the whole distance in the high-water channel of the Bauang River, and is located on the right bank of the river well above high water. The road passes through a typical foothill section broken by numerous drainage courses and low ridges necessitating frequent adverse grades and curves. In the location of the Naguilian-Ribsuan section little

The main ascent is made at the lower end of this section and the road placed as near as possible to the top of the ridge, passing over a series of saddles or low connecting ridges, for the entire distance to Baguio. This eliminates large drainage areas above the road and the necessity for placing large drainage openings under the road.



Kilometer 5, Baguio-Naguilian Road, Mountain Province.

value was attached to the trail and the present road coincides with it in about two places through barrios. Leaving the level rice fields surrounding Naguilian and crossing a number of low-lying ridges, necessitating adverse grades, the road is in side-hill cuts bordering the Ribsuan River to the crossing at barrio Ribsuan, the boundary of La Union. The location of the mountain section from Ribsuan to Baguio consisted mainly in revising the alignment and grade of the old trail. The section of the road from Ribsuan to kilometer 32 is entirely a replacement location and eliminated a section of the old trail that had proved hard to maintain and where heavy gradients and large drainage openings would have been required. The new



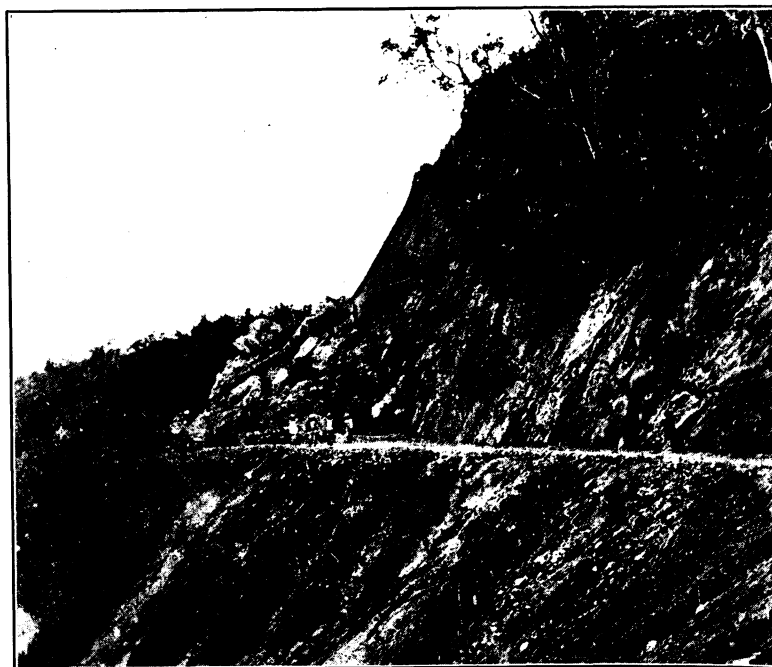
Kilometer 11, Benguet section.

In the construction of the lowland section the work was accomplished under the supervision of the district engineer of La Union largely during the dry seasons of 1912 and 1913 without the necessity for rush work or the employment of large labor organizations. The cost of this portion of the road compares favorably with the average cost of lowland construction elsewhere in the Ilocos Provinces.



Kilometer 5, Baguio-Naguilian Road, Mountain Province.

location also affords a better bridge site at the Ribsuan River. No attempt was made to balance cuts with fills, as it was desired to secure the best possible location within the funds available. As compared to the Benguet Road, the reverse scheme has been followed in the location of the mountain section of the Baguio-Bauang Road.



Revising grade and alignment of old cart road, kilometer 14, Benguet Province.

Construction work on the Benguet section was started January 20, 1914, and continued through the rainy season, completing the grading work on December 20, 1914, and the surfacing March 25, 1915. The original estimate and plan contemplated accomplishing the work in the most economical manner possible, but several months after the



work started it was considered advisable to complete the grading work under way from Baguio to kilometer 25 and kilometer 31 to kilometer 34 before the rainy season, and to handle the work after this time so that the new road and old trail might be opened to traffic on short notice in case of interruptions to traffic on the Benguet Road. This necessitated the employment of a large number of laborers and rush work on these sections, increasing the cost of the work fully 35 per cent. The largest labor organization at any time during the work was 7 American, Spanish, and Filipino foremen; 14 Filipino subforemen; and about 2,500 laborers. Practically all the labor employed was non-Christian from the Mountain Province and the price paid varied from 35 centavos per day with rations to 50 centavos and rations when the work was being rushed. The average cost of a day's ration was 16 centavos. A total of 13,882 lineal meters of the road was graded by force account at an average cost of about 30 centavos per cubic meter for moving dirt and ₱2 per cubic meter for rock work. The road is in side-hill cut for practically the whole distance and radical reduction in grades and curvature of the old trail was accomplished by very heavy cutting and filling. Solid rock work was encountered on 2,200 lineal meters of the road and approximately 16,000 cubic meters of rock moved from cuts and

The contractors were furnished the necessary tools and dynamite and given a flat price, decided upon in all cases before work was started and usually including a sufficient amount of rice to feed their gangs while the work lasted. This system proved not only very satisfactory, but about 50 per cent cheaper than excavation done by force



Road construction through Yagyagan Hills, kilometer 9, Benguet Province.

in side-hill work. The other classes of material moved varied from clay to a decomposed sandstone formation with large conglomerate boulders. The roadbed was laid out and constructed with a 6-meter roadbed both in cuts and fills except on two short sections where heavy rock was encountered, and where there is a 5-meter roadway. On the upper section of the road, graded before the 1914 rainy season, no attempt was made to cut high slopes to stand with the idea that it would cost less to move the material brought down by rains. The result was that the first heavy rain and later rains caused a large amount of sliding from the upper banks. This material was moved to advantage with 2-mule drag scrapers at a cost of about 10 centavos per cubic meter, or a total cost of ₱22,808.40 which represents a saving in excavation of ₱45,616.80. While this method of grading proved economical, it would not be good practice in places where slopes and new fills would be seriously damaged by surface drainage, as drainage openings and drains are apt to become stopped and drainage diverted over the road bed.

A portion of the road 12,118 meters long was graded by contract at a total cost of ₱16,684.99, or at an average cost of about 16 centavos per cubic meter. The "paquiao" system of contracting excavation work was used and sections of the road from 20 to 500 meters long given to a contractor, the length of section depending on the size of his gang and the amount of material to be moved.



Slide below old Spanish trail, kilometer 14, Benguet Province.

account. Practically all of the contractors were Benguet and Bontoc Igorots and there was not one case of a contractor giving up a job on account of misunderstandings or a low price. Excavation was done by contract during the rainy season where water was available for sluicing as low as 8 centavos a cubic meter; the contractors being familiar with this method of excavating, as this is the usual practice in constructing hillside rice paddies in the Mountain Province. It was often necessary for contractors to build ditches over 500

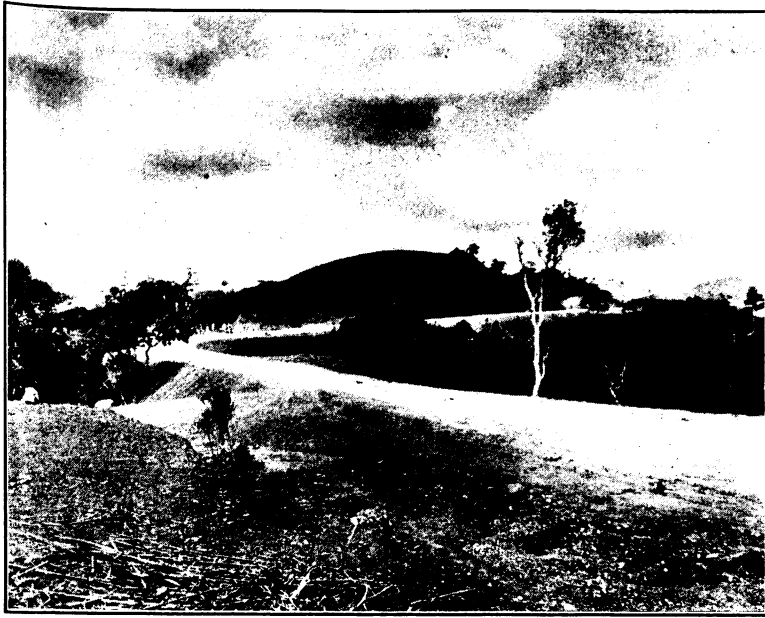


New road and old cart road above kilometer 11, Benguet Province.

meters long to secure a sufficient amount of water for sluicing heavy cuts. Where material was required for making fills, it was sluiced into place and held by dry rock walls or sheet piling made tight with banana leaves or grass. The sections of the road graded by contract was left with slopes varying from 1/4 on 1 to 1 on 1, according to the materials encountered.

No large structures were required on the mountain section, but a large amount of dry-rubble masonry was used on constructing retaining walls and end walls for drainage openings. An accompanying photograph shows the roadbed held on a very narrow saddle, that had to be widened, by a dry-rubble retaining wall 16 meters

and the price paid was from ₱1.80 to ₱2 on the sections from kilometer 8 and from kilometer 30.5 to kilometer 34. The maximum haul on the upper section was about 2,000 meters with an average haul of 200 meters and the maximum haul was 3,500 meters on the lower section. Two 8-ton and two 10-ton road rollers were used in preparing



Finished section of road over Yagyagan Hills, kilometer 10, Benguet Province.

high and built on a radius of curvature of 40 meters. The roadbed is supported in a number of other places by dry-rubble retaining walls varying in height from 1 to 10 meters. The use of this class of masonry is probably one of the principal economies effected in construction, as the Igorot was also found to be a good mason and the cost of cement is excessively high in this locality due to cost of transportation.

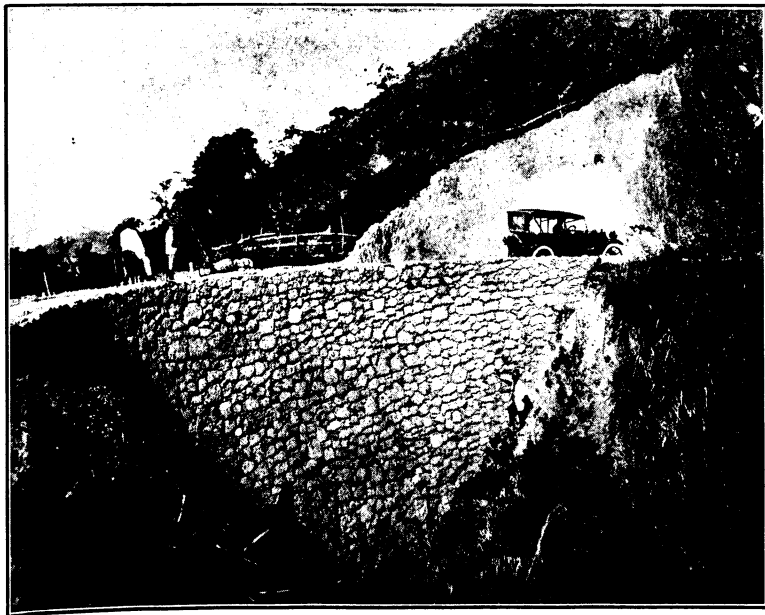
All material used in the surfacing of the road was contracted for



Finishing up the last big cut, kilometer 20, Benguet section.

subgrade and rolling surfacing material into place. A 6-ton roller was also used rolling fills where heavier rollers could not have been used to advantage. Special attention was given to the protection of fills by placing banks on the outside of the roadbed to keep drainage from going over the slopes of fills, and by planting cogon grass on the slopes of high fills so as to form practically a cover against rain.

The maximum gradient used in the construction of the Baguio-Bauang Road is 9 per cent and the minimum radius of curvature is 15 meters. In several places on the mountain section where it would have necessitated very heavy cutting and filling to correct the



Road bed held at a narrow saddle by a dry-rubble retaining wall, 16 meters high, kilometer 11.

and broken by hand along the roadside. The cost of breaking and quarrying varied from ₱0.60 to ₱1.10 per cubic meter for first-course and from ₱0.90 to ₱1.20 for second-course and finishing material, the Government furnishing the tools and dynamite. The breaking and delivery of rock was contracted for on 24 kilometers



Kilometer 14, Benguet section.

grade of the old trail the minimum radius of curvature was reduced to 10 meters. Whenever a radius of curvature of less than 50 meters was used, the roadbed was widened, and the gradient compensated by reducing the gradient on the curve. The maximum grade is on the section from Ribsuan, kilometer 34, to kilometer 30.5,

where the road makes an ascent of 233 meters (764 feet). The maximum grade from kilometer 30.5 to Baguio is 8 per cent. The total ascents from Ribsuan to Baguio aggregate 1,513 meters and the total descents 77.7 meters.

There are 303 minor structures on the mountain section of the road with openings for drainage aggregating 228 meters total span as compared to a total of 234 structures on the Benguet Road having a total length of 2,271.62 meters. The following is a complete list of structures built on this section:

For small drainage openings where rock was easily obtainable dry-rock box culverts were used instead of pipe drains. The cost of building these culverts was about half the cost of concrete or galvanized-iron pipe drains. In locations where it would have been necessary to place pipe culverts under high fills to take care of drainage in natural courses, the ravines were filled so as to divert the drainage and the pipes placed in cut. This necessitated larger fills but eliminated high end walls on culverts.

The only bridge and timber structure on the mountain section is

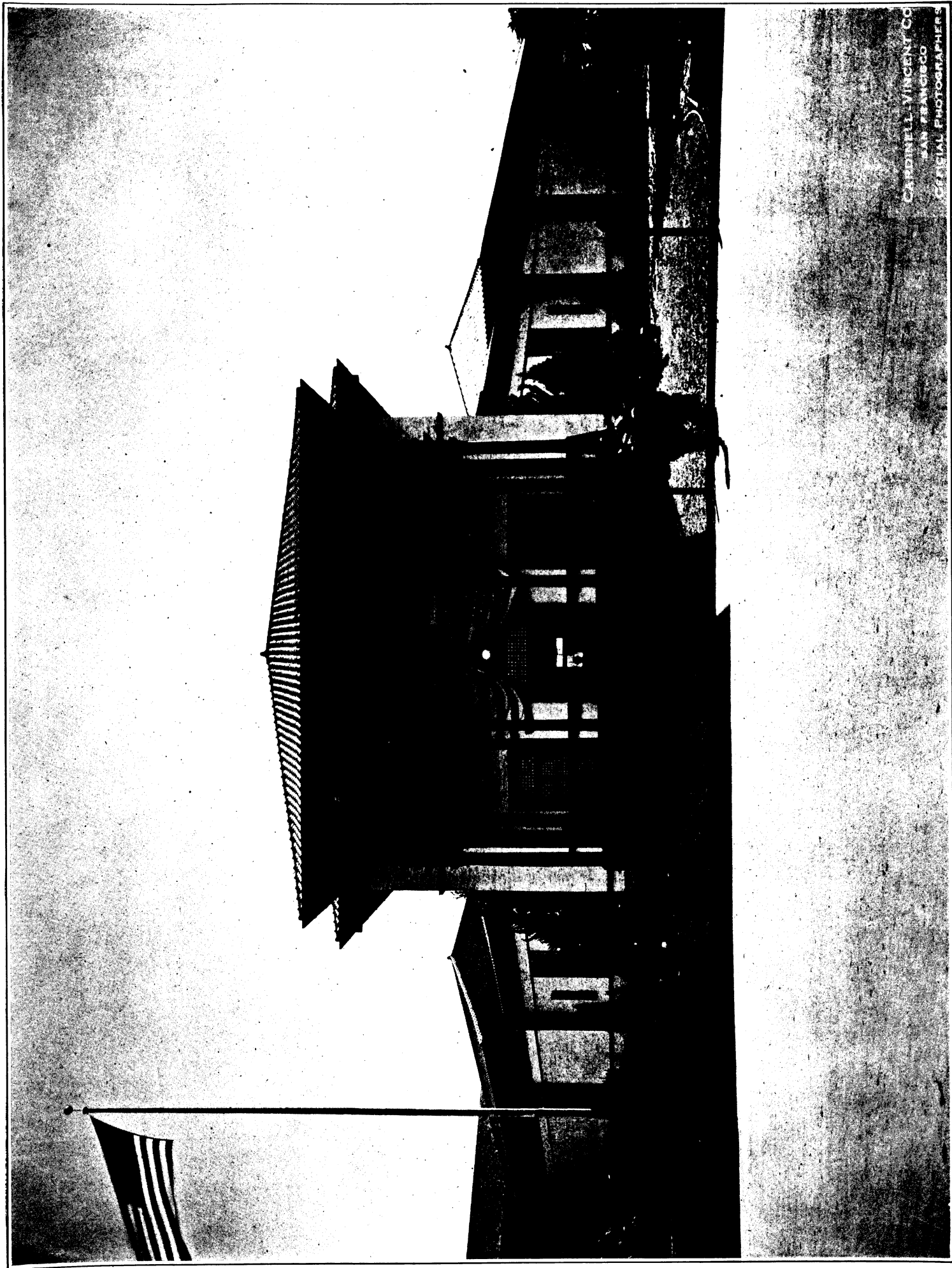


72-inch galvanized pipe culvert, kilometer 28, Benguet section.

8-inch vitrified pipes.....	16
0.5 by 0.8 meter rock culverts.....	72
24-inch concrete pipe drains.....	69
American ingot iron pipe culverts:	
18-inch .....	76
24-inch .....	22
36-inch .....	12
48-inch .....	14
60-inch .....	4
72-inch .....	4
3 by 3 meter rubble masonry culvert.....	1
60-foot timber pony truss bridge.....	1
80-foot collapsible bridge.....	1

a 60-foot timber pony truss bridge with girder approaches across the Irsan River, kilometer 8. This bridge was built during 1912 by the city of Baguio and Mountain Province. It was designed for a maximum load of 8 tons, but has been strengthened to carry 10 tons and will be serviceable for several years longer. Timber collapsible bridges are used at the Ribsuan and Naguilian River crossings. A good bridge site is, however, available at the Ribsuan River and it is proposed to replace the present collapsible bridge with a 300-foot steel structure during the coming year. In addition to the collapsible bridge across the low-water channel of the Naguilian





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River, an aerial cableway is being erected of sufficient capacity to allow the transfer of passengers or freight during flood stages when crossing the river in a boat is dangerous on account of the very swift current at this point. A car will be provided large enough for carrying a horse and operated by a hoisting engine. The three timber towers to support the cableway are being erected on concrete foundations which will later be utilized as abutments and center pier for a bridge. The type of bridge for this site has not been definitely decided upon, and an appropriation for the construction of a permanent structure will probably not be made for several years. A structure of a total span of about 550 meters will be required, and a design similar to the Laoag Bridge will probably be followed.



60-foot timber truss across Irian River, kilometer 8, the only timber structure on the Mountain section and the only bridge in 34 kilometers.

With the completion of the proposed railroad bridge across the Bauang River and the extension of the railroad line to the Bauang station site on the right bank of the river, the necessity for crossing the Bauang River to connect with the railroad will be avoided. A collapsible bridge is also used in crossing this river during the dry season, but a bamboo raft has to be depended upon during the rainy season on account of a shifting river channel making it practically impossible to maintain a collapsible bridge. The remaining structures used on the La Union section are constructed of concrete, excepting four timber culverts on the Naguilian-Ribsuan Road and two girder bridges on the Bauang-Naguilian section.

The metaling on the road has been placed 4 meters wide from Baguio to kilometer 17 and from kilometer 30 to Bauang, increased in width on curves depending on the radius of curvature. In order to effect a saving in the cost of construction, the width of metaling was reduced to 3 meters on the section from kilometer 17 to kilometer 30. The depth of metaling varies from 6 to 9 inches, and a number of different classes of material was used. The city section of the road is surfaced with a good quality of limestone rock and the La Union section with a good grade of river gravel. On the Benguet section rock easily obtainable along the road and varying from a diorite or andesite to a fair quality of sandstone was used for first-course material and the best grade material was used for the finishing courses. In order to provide a better wearing surface for the heavy traffic, which the road will be subjected to, it is proposed to resurface the entire road later and to widen the section with 3 meters of metaling of an excellent quality of hornblende and andesite from a quarry at kilometer 20, and with limestone from the city of Baguio. This class of material will also be used in the maintenance of the road.

The following financial statements show the cost of constructing the Benguet section and previous expenditures by La Union Province, Mountain Province, and the city of Baguio which make up the total cost of construction:

Appropriations, Benguet section:	
Insular appropriation under—	
Act No. 2312	P100,000.00
Act No. 2396	135,000.00
Act No. 2411	60,000.00
Insular aid	24,031.81
Total appropriation	319,031.81
Expenditures, Benguet section:	
Miscellaneous	P6,858.34
Labor	203,793.14
Materials	71,327.94
Surcharges (Insular and provincial)	8,439.95
Insular aid	24,031.81
Liabilities:	
Labor	735.00
Materials	2,259.63
Surcharges (Insular and provincial)	1,586.00
Total	319,031.81
Balance	None.

Previous expenditures on construction work were as follows:

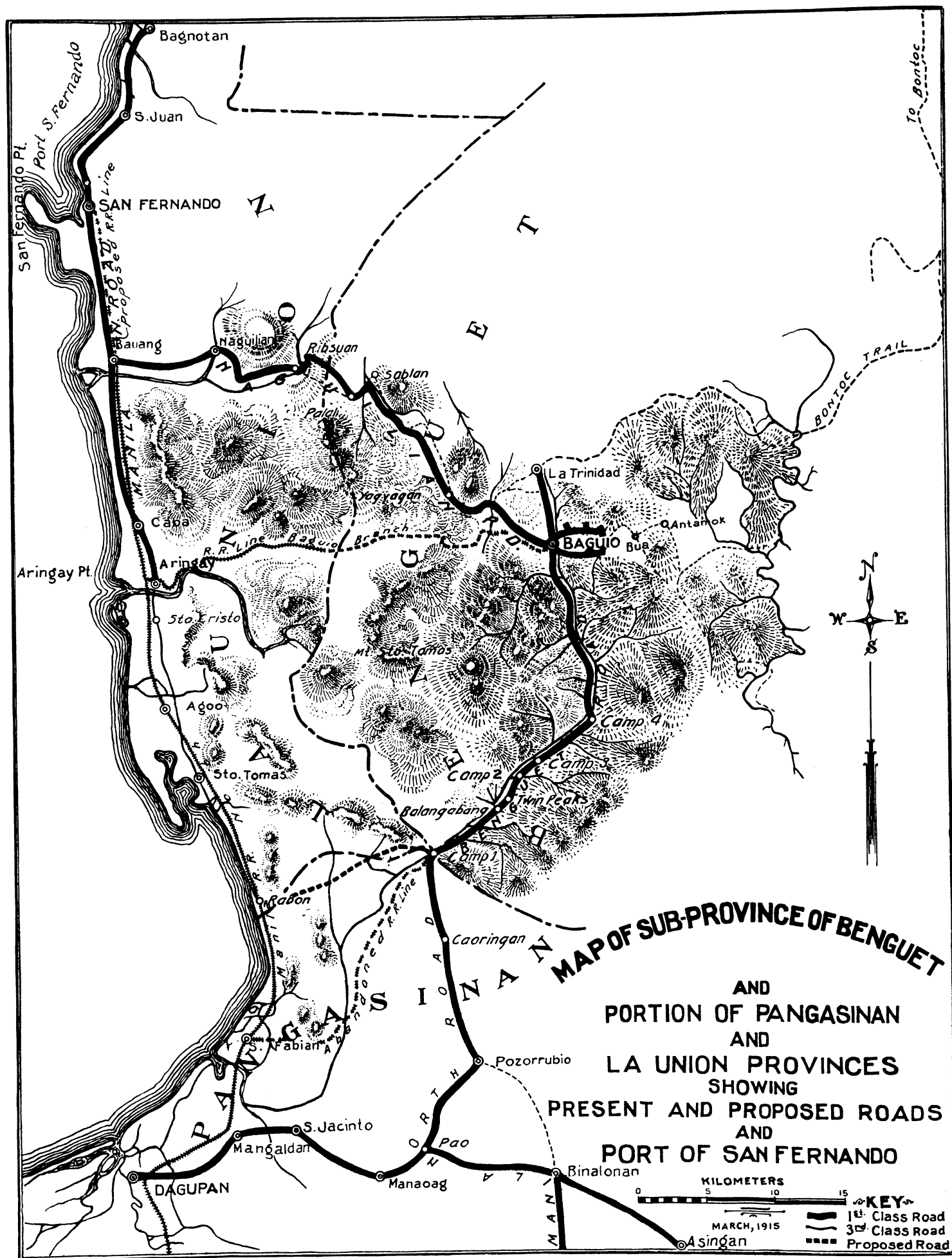
La Union Province:	
Construction of Bauang-Naguilian Road, including culverts...	P52,483.64
Construction of Sapang Bridge, Bauang-Naguilian Road.....	8,904.76
Construction of Pidpid Bridge, Bauang-Naguilian Road.....	9,720.98
Construction of Naguilian-Ribsuan Road, including culverts..	97,779.59
	P168,888.97
Mountain Province:	
Construction of Naguilian Trail in the subprovince of Benguet including one-half cost of the Irian Bridge.....	85,017.85
City of Baguio:	
Construction of Irian Road from the city hall to Irian River, including one-half cost of the Irian Bridge.....	58,743.27
Total	312,650.09
Total cost of construction:	
Expenditures, Benguet section (including Insular aid).....	P319,031.81
Expenditures by La Union Province, Mountain Province, and city of Baguio.....	312,650.09
Total	631,681.90



3 by 3 meter arch culvert constructed of rubble masonry in a 17-meter canyon, kilometer 8.2, Benguet section.

In this connection the cost of constructing and the cost of maintaining the Benguet Road to December 31, 1914, may be of interest:

Original cost of construction.....	P3,923,694.10
Maintenance, including reconstruction of bridges and other betterments; fiscal year—	
1906	P128,879.24
1907	84,916.55
1908	164,363.65
1909	299,947.19
1910	358,685.82
1911	166,528.42
1912	253,471.58
1913	179,276.28
1913 (July 1 to Dec. 31)	129,768.01
1914 (calendar year)	51,836.01
	1,817,672.75
Total	5,741,366.85



In the location of the Baguio-Bauang Road it would seem that special attention had been given to scenic features. As compared to the Benguet Road, where the view is confined for practically the entire distance to a typical mountain gorge, this road affords a variety of scenery. Beginning at a point a short distance from the seaside at Bauang the road parallels the Bauang and Ribsuan Rivers, passing through a foothill section and the Naguilian Valley to Barrio Ribsuan. Leaving the river, the road climbs to an elevation of 250 meters (820 feet) in 3,500 meters where a view can be had covering a distance of 60 kilometers (37 miles) across the plains and the Gulf of Lingayen to Bolinao Point at the extreme northern end of Pangasinan Province. On this section is found one of the most pleasing features of the road and must be seen to be fully appreciated. The development includes three hairpin curves. The road follows approximately the top of the ridge for the rest of the distance to Baguio, crossing from the east to west slope of the ridge seven times over saddles or low connecting ridges. From the west slope a continuous view of the coast can be had and on the east slope an extensive mountain view. At kilometer 9 can be seen the track section of the Baguio branch railroad under construction 2,000 feet below the road and the rugged Irisan River gorge made



Part of Zigzag showing cultivated areas of mountain rice land near Ribsuan, kilometer 31 to kilometer 33.

up of a series of falls and with a total fall of 1,800 feet in 1,000 meters. The last view to the coast and the first glimpse of the city of Baguio is at kilometer 4. The scene from this point to the lowlands and coast is probably the most picturesque on the road and once seen can never be forgotten.

The location and construction of the Bauang-Naguilian and the Naguilian-Ribsuan Roads were under the supervision of Mr. E. D. Smith, as district engineer of La Union. The section of the road from Ribsuan, kilometer 34, to kilometer 32 was located and constructed by Mr. Dana Q. McComb, former district engineer of La Union. The work of converting the old Naguilian horse trail in Benguet Province into a cart trail was accomplished under the supervision of former Lieut. Gov. E. A. Eckman. The mountain section of the road from kilometer 32 to Baguio was located and constructed under the supervision of the writer with valuable assistance from Lieut. Gov. J. E. Evans, subprovince of Benguet, in the organizing and supervising of labor.

## USE OF EXPLOSIVES IN DRIVING REINFORCED CONCRETE PILES.

By FRANK T. JAMES, Assoc. Mem. Am. Soc. C. E.

Oftentimes reinforced-concrete pile bents, because of their less cost and usual promptness of construction, are the most reasonable type of piers for use in bridges over wide rivers with no definite banks,

but wherein the riverbed soil is harder and more nearly impenetrable than in locations where soft material such as sand or clayey mud make the use of this type ideal.

In driving concrete piles for the Cabugao Bridge, Ilocos Sur, the writer encountered strata of gravel compacted with sand and clay and carrying boulders up to 10 inches in diameter, and decided to try powder or dynamite to loosen up the material in the paths of the piles. He had used black powder with some success in stiff clay on another bridge job the previous season, and the results seemed to warrant the procedure here.

It was desired that the piles penetrate to elevation  $-6.80$ , the ground being approximately elevation  $+0.20$ . It had been noted that in the clay the powder loosened the material *above* it for a certain distance, and to just about the point to which the charge had been lowered before exploding. In other words, to loosen material to elevation  $-5.00$  we should push the charge to approximately that level.

It was desired, on the Cabugao job, to explode the charges at elevation  $-6.00$ , thus affording about 80 centimeters of driving of the tapered point of the piles into the original undisturbed material. Expecting that its action would be through a greater range horizontally and with probably more force upward, it was decided to use Judson powder R. R. P. The method of procedure is given below.

The pile driver was moved into place for driving the pile and a 6-meter length of 3-inch galvanized-iron pipe hoisted into the leads. A coupling had been screwed on to the hammering end of the pipe to protect the threads in driving, and on the end entering the ground a cap was placed. This cap was made of a piece of old steel plate  $\frac{1}{2}$  inch thick and about 7 inches square, notched on four sides about 2 inches. The corners were then bent up square and into a circle practically the diameter of the outside diameter of the pipe. Into a hole punched in the center of the plate a piece of  $\frac{3}{4}$ -inch steel 2 inches long was driven hot and snug. The cap was fitted over the end of the pipe at just ground level and the protruding point served as a guide to keep the cap and pipe going straight. Thus the cap, while it did not keep the water out of the pipe, prevented the earth from entering and filling it.

While the driver was being moved into place and the pipe prepared for driving, the charge of explosives was simultaneously prepared and had to be ready before the writer proceeded further. Then with short blows of the hammer the pipe was driven into ground for 6 meters. The charge was then lowered into the 3-inch pipe.

The charge was really a long cartridge. Into a tin tube of  $2\frac{1}{2}$  inches diameter and 1 meter long Judson powder R. R. P. was tamped to a depth of 75 centimeters. Then there were placed two sticks of dynamite, with a 6-meter fuse and cap in each, on top of the powder. Another stick of dynamite was broken into four pieces and tamped in around the exploder sticks along with more Judson powder R. R. P. up to within about 4 centimeters of the top of the tube. On top of this there was rammed some of the thin paper in which fuses are packed, and the tube was sealed with asphalt or white lead, crimping the end of the tube slightly.

When the bottom of the tube was down to the bottom of the pipe and resting on the cap, a 6-meter length of 1-inch pipe was run down on to the top of the cartridge and held there by two laborers on the driver. The cable was then hitched to a rope fastened around the top of the pipe and with the engine the 3-inch pipe was gradually withdrawn, leaving the cap and tube down in the ground, withdrawing the 1-inch pipe after the 3-inch had been lifted about 2 meters, which meant that the earth had in all probability filled in around the tube.

Immediately the pipes were out of the ground the fuses were lighted and the charge exploded. The driver was then moved into place for the next pile but one and the operation repeated and then to the second pile beyond that. This gave three explosions for the bent of five piles which were spaced about a meter apart. The concrete piles were then driven and with very satisfactory results as to grade, the bearing being much more than required.

These facts should be noted:

1. There must be a steel cap on the penetrating end of the pipe as a wooden plug splinters and forces itself up into the pipe.
2. There must be a coupling on the driving end of the pipe as



the thickness of metal is too small at the base of threads to permit of hammering without crimping the edges. The coupling serves also as a collar with which to grip the pipe with a rope when withdrawing it from the ground.

3. A block of wood, preferably hard, should be used on top of the coupling as a further protection for the end of the pipe as the driving is very hard and sometimes requires three or four blows of the hammer to start the pipe into the first hard stratum encountered. The blows of the hammer cannot be increased greatly for the galvanized-iron pipe will bend.

4. The 3-inch pipe should not be driven until the cartridge is all ready, because once in a while the cap slides off of the end of the pipe when down at a considerable depth and the charge must be put in immediately before the earth works itself in, or the pipe will have to be withdrawn and driven again.

5. Dynamite is absolutely necessary to explode Judson powder R. R. P. The manufacturers handbook states the size and number of sticks to be used for different sized charges. The charge we used was about 6 pounds and required two  $\frac{7}{8}$ -inch sticks.

6. In every charge of dynamite there should be two fuses and two caps as a minimum. One fuse and cap is not enough as often times a fuse that burns well for half its length or more, dies before reaching the cap, sometimes right at the cap, if the latter has been crimped too much or improperly. Using two fuses and two caps lessens the chances of failure to explode. One of the fuses should be a foot or more longer than the other, and the longer one lighted first, to ensure reasonable safety to the man doing the igniting. This must be done quickly, hence a torch or other large flame is best for speedy action.

## PUBLIC WORKS—PAST AND PRESENT.

By J. L. HARRISON, District Engineer.

### BULACAN PROVINCE.

For many years Bulacan has been a populous and prosperous province. Lying as it does in the central plain of Luzon, it is for the most part a level country, fertile and well watered. At the present time most of the population is engaged in farming, though when the Spaniards first arrived, some three hundred years ago, the population is said to have been small and to have been almost wholly engaged in fishing. It is claimed that the Spaniards introduced rice culture into this country, and it is certainly true that they stimulated it greatly and by so doing materially increased the food supply of the Islands. They also increased the production of sugar cane and other agricultural products, and in many ways opened new fields for labor, thus permitting the gradual growth of the population. The fishing business still remains, and the fishermen of to-day undoubtedly catch as many fish as their ancestors caught three hundred years ago, but they are now only a small proportion of the population. The bulk of the wealth of the province comes not from the fisheries but from the fields that were then well-nigh untouched.

At first the hold of the Spaniard was slight, but as time passed the power of the central government at Manila was felt farther and farther from the garrisoned towns. As this power became more defined, provincial governments were set up, provincial officers appointed, and a program of public improvements was undertaken. In Bulacan Province this program seems to have contemplated the construction of an extensive road system, some irrigation works, a few minor undertakings such as a provincial government building, etc. The program was not completely followed out. Some of it probably never got beyond the drawing board, and about all that remains of importance to-day is some irrigation works and the road system, which is valuable because through it much of the right of way for the modern road has been secured.

A study of the old road system is interesting because it is typical of the difference in the theory underlying Spanish public works and those of the present day. When the provincial government of Bulacan was established, the town of Bulacan was made the capital of

the province. It was the center of the provincial authority, both civil and military, and was connected with Manila by a military road and, in theory at least, with the capital of the next province to the north. Four other highways radiated from Bulacan like the spokes of a wheel, the whole system giving the unmistakable impression that the economic needs of the province were not considered in laying it out, but that the purpose had been to follow the Roman theory and build a road system that would be most effective for military purposes.

It is almost impossible to say just how much the Spanish Government did toward completing the system. The older residents often assert that a good deal was done, and there are provinces where it is probable that the Spanish road system was at one time in good shape, but aside from the fact that travelled roads exist on all of the old routes, there is surprisingly little evidence that anything was done to improve the majority of the roads in this province. This is not surprising when the Spanish laws governing the building of roads are studied. These laws made practically no provision for the imposition of taxes for road purposes, but provided that every able-bodied man must work on the roads a certain number of days each year. It was also provided that this work should be done under the local municipal authorities. A very similar system has given the United States the distinction of having the worst country roads of any great nation in the world—a distinction so unquestionably deserved at one time that it was nowhere disputed, so it is probably unnecessary to comment further on possible reasons why more was not done toward completing the plans that were made by the Spaniards.

Notwithstanding poor laws and inefficient management, however, some of the roads were graded and surfaced. It would be very interesting to know how the surfacing was done, and more especially whether there was any well-defined standard of construction; but this is a very hard matter to determine. In the first place, the provincial authorities seem to have built roads about as they thought best. Often the matter was left entirely to the municipal presidents, who were simply directed to make the roads passable, and did so in whatever way seemed the easiest. Fairly substantial work sometimes resulted, but often no more was done than to lay heavy bamboo or brush mats over the bad holes and cover the brush with a light blanket of earth. Moreover, the insurrection which swept over this region about two years before the arrival of the Americans was not so completely stamped out as to permit the establishment of normal conditions for four or five years. During this period armies marched back and forth, and the stress of war destroyed many of the Spanish roads, while on others the military authorities spent large sums of money in various forms of reconstruction. Very little of the old Spanish construction remained in Bulacan Province when civil government was reestablished, and to ascertain what forms of construction were in use during Spanish times one must rely on the testimony of the older men of the community and on such bits of material evidence as can be secured by examining old roads that are not now a part of the heavily traveled routes. Such sources are apt to yield evidence that is confusing, but it is felt that two cases at least may be cited as fairly representative of Spanish methods of maintenance and construction.

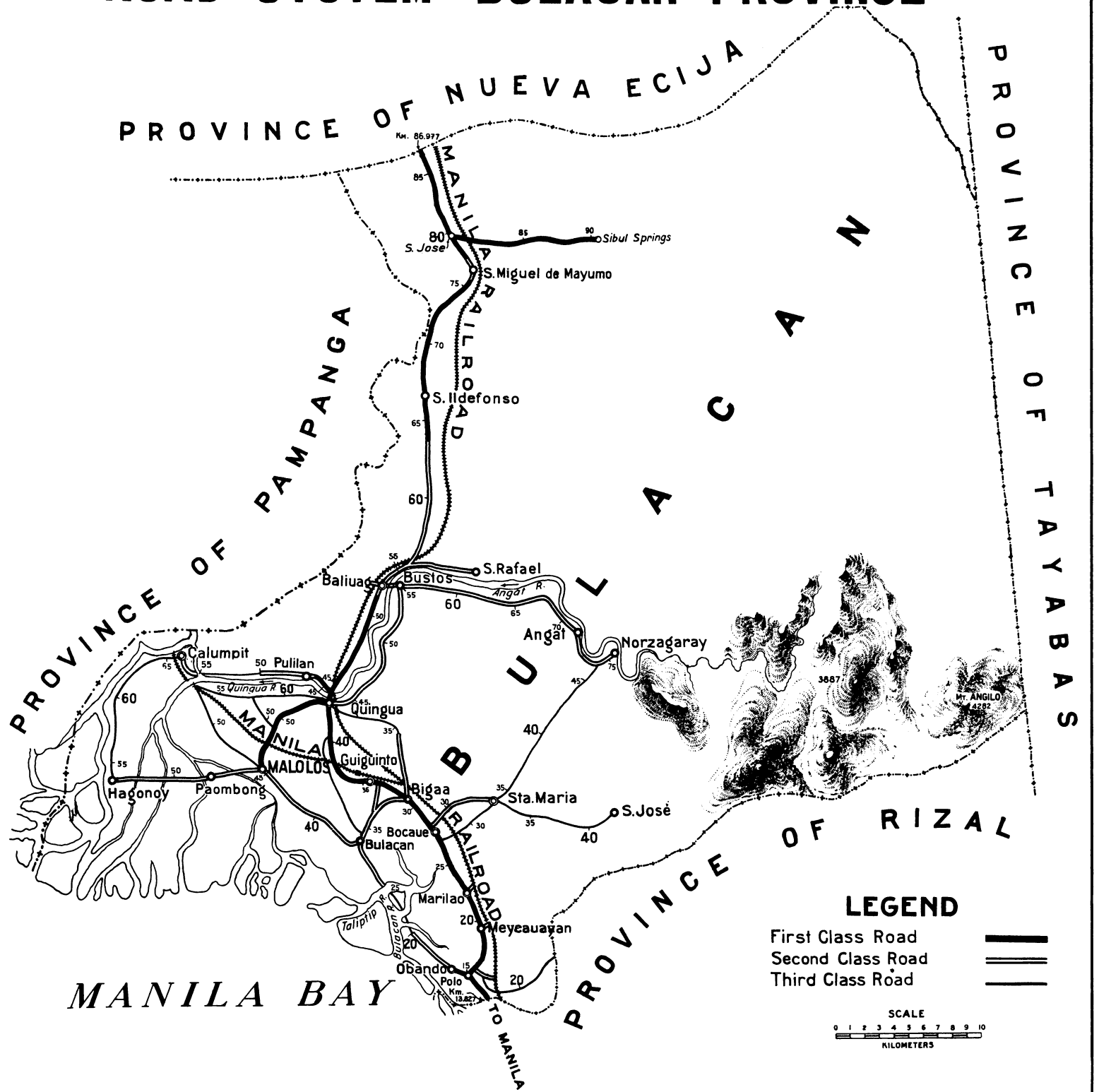
During the Spanish régime one of the main highways of the province was the road from Bulacan to Quingua. Some years before the end of this régime the condition of the road displeased the Spanish governor, and he ordered the president of Bulacan to make thorough and immediate repairs. The president, desiring to do a satisfactory job, gathered together the men of the town and had them cut adobe stone blocks about a foot square and approximately 6 inches thick. All of the soft places in the road were paved with these blocks, the whole of the road was then covered with 3 or 4 inches of coarse gravel, and this in turn was covered with a few inches of earth. The idea seems to have been that, as an earth road was smooth but likely to develop mud holes during wet weather, the proper procedure was to build stone foundation that would prevent the formation of mud holes, and then to cover this foundation with enough earth to insure a smooth road during dry weather. The stone foundation naturally drained quickly, so that even during the wet season this kind of road

dried off more rapidly than the surrounding country, and was therefore better than an ordinary earth road.

Gravel and macadam roads in this province, as those terms are now

road only the pieces from 4 to 6 inches in diameter were selected. These were carefully laid on subgrade raised somewhat above the surrounding rice fields, and a road with these stones in place presents

# ROAD SYSTEM—BULACAN PROVINCE



universally understood, seem to have been almost, if not entirely, undeveloped by the Spaniards, who confined themselves to the cheaper and more primitive types of construction. The road from Angat to Marunco is typical. Here the nearby river bed contained any quantity of aggregate from fine sand to small boulders, but for building this

much the appearance of a cobble stone road as built years ago in the United States. Two or three inches of earth was placed over the stone course, and the road was opened to the public. Such a road was reasonably serviceable for light traffic, was smooth and easy to travel on during dry weather, and was always passable during wet



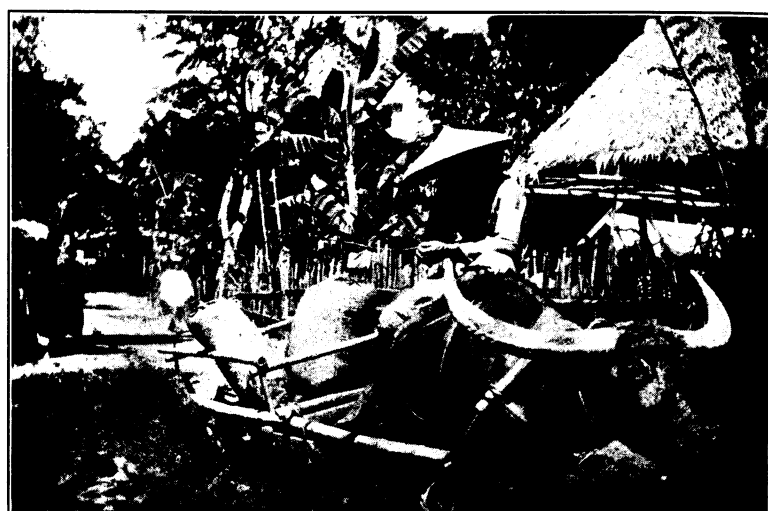
The rice fields of Bulacan Province as seen from the Manila-North Road between the towns of Bocaue and Bigaa, Bulacan Province.

weather. If the traffic was so heavy that the stones were displaced during the wet season, the road was rebuilt a little heavier, but no effort seems to have been made to prevent failures either by insuring

forms of construction, and just about as good for military purposes. There is enough truth in this assumption so that, coupled with the indisputable fact that the roads were only incidentally for the benefit



First-class road, Quingua-Baliuag, Manila-North Road.



Third-class road, Hagonoy-Calumpit, Bulacan Province.

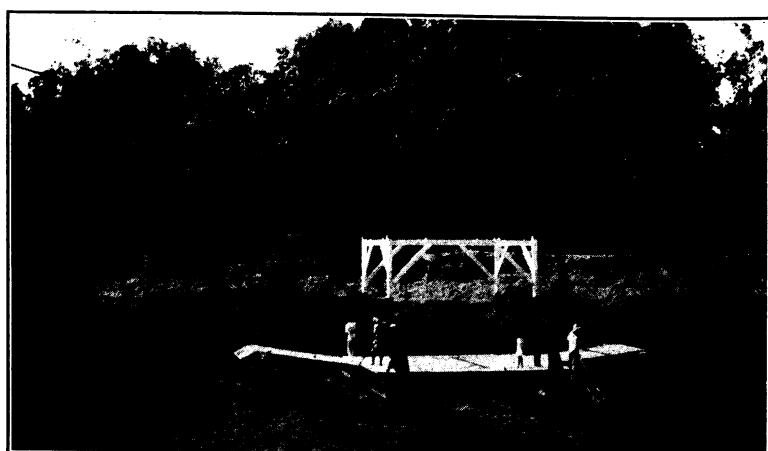
better drainage or by improving the type of construction. It strikes even the casual observer as peculiar that the engineers of that period never attempted to improve the roads in Bulacan by the simple process of covering the stones with a course of fine gravel and binder;

of the people, it may explain why more was not done to improve the standard of road construction.

Spanish bridge construction in Bulacan was fully as primitive as Spanish road building, though in the Provinces of Cavite, Laguna,



Second-class road, Maasin-Baliuag, Bulacan Province.



Bagbag Ferry, Bulacan Province, American design.

but while it might not be safe to assert that they never did so, it is certainly true that they rarely followed this system, perhaps acting on the assumption that their roads were cheaper than more modern

and Batangas there are some excellent bridges remaining. In Bulacan Province there is only one steel-truss bridge of Spanish design, though at another point a substructure had been completed, evidently

with the idea that at some future date it would carry a steel span. Timber bridges were common, especially where stone was scarce or hard to cut; but most of the timber structures were short beam spans. Where a framed structure was used it usually partook more of the qualities of a timber arch than of a timber truss. An old structure

side by a space of 6 meters, are two lines of timber columns, over the tops of which there is a heavy timber cap. The roof rafters are fastened to the wall at their lower end and pass over the cap to the ridge which is formed by fastening together each pair of intersecting rafters. The only semblance of truss action that can be found



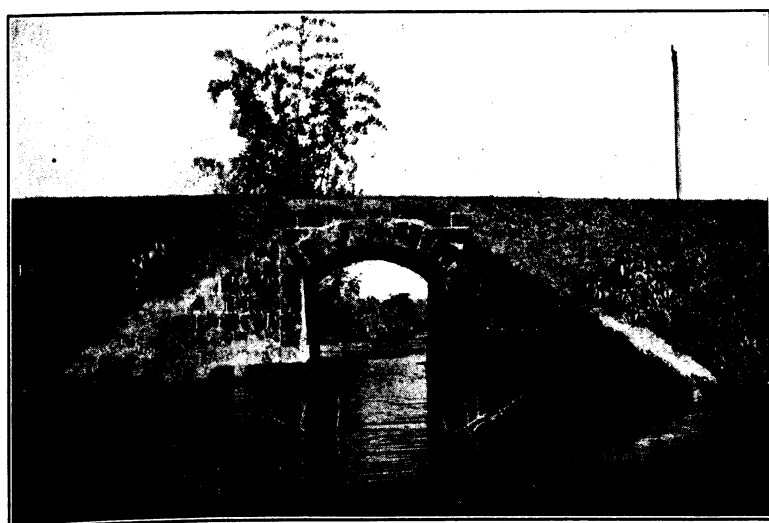
Typical bamboo bridge of native construction, Hagonoy, Bulacan Province.

at Ormoc, Leyte, spanning an opening about 16 meters wide, is typical. The floor was carried between two framed affairs somewhat resembling trusses, but even a casual glance served to show that what appeared to be a four-panel truss was not a truss at all, for it lacked some of the diagonal braces. What appeared to be the bottom chord was not even connected to the end posts. On each side of the stream a deep hole had been dug and two timbers set in the ground at an angle of about  $45^\circ$ . For some bridges of this type these timbers were set in masonry, but in this instance the holes were merely refilled with earth. These timbers projected about 5 meters beyond the abutments and the distance between the timbers projecting from opposite banks was spanned by a horizontal "top chord." Abutments protected the banks from scouring back and a timber was laid between these abutments as a false "bottom chord." Three long bolts connected the "bottom chord" and the "top chord." The floor rested on the "bottom chord." The complete structure had much the appearance of a truss, practically all of the members of a truss being present, but it failed absolutely to partake of the characteristics of the truss form of construction.

in this whole roof, and the building is a large one, is where an effort has been made to strengthen the ridge by bolting a short piece of timber to each pair of intersecting rafters about 2 feet below the ridge.

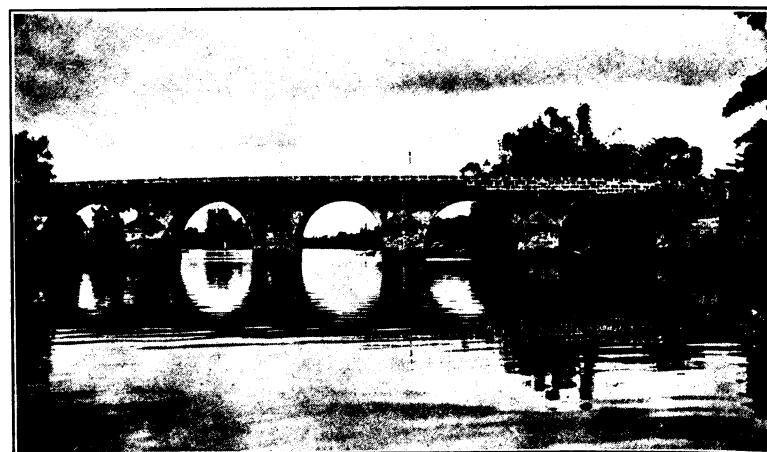
Nor did the Spaniard, in this province, seem to utilize the more complicated forms of arch construction as the elliptical or the segmental. It is true that a good many circular-arch bridges were built during the old régime, and it is popularly supposed that the Spaniard was a great and very successful user of this type of construction, but an examination of even the best of the Spanish arch bridges reveals most surprising limitations. In the first place, the Spanish authorities seem to have feared to use spans longer than about 11 meters. It is said that a few longer spans exist in the Philippine Islands, but the writer has never seen one. Perhaps the limitations were due to the softness of the stone available.

So short a maximum span length, itself a serious matter, was made doubly so by the fact that the Spanish authorities appear to have depended upon the spread foundation and large piers for stability. The Meycauayan Bridge is typical of such construction. It is composed of five semicircular arches, each with a span of about 7.1 meters. Between the springing lines at the two abutments this bridge measures 51.2 meters. From bank to bank the normal width of the stream is



A Spanish culvert of about 4 meters span, Bulacan Province.

The scientific construction of roofs was not well developed, and here, as in bridge construction, the use of the truss was rarely used. The Barasoain church roof is typical of the construction of that period. The outside walls are approximately 20 meters apart. Inside of these walls and parallel to them, but separated from them on either



Meycauayan Bridge, Bulacan Province, Spanish construction.

about 60 meters. Such constriction of the channel can only result in disaster unless the stream has very little current. As Spanish piers were usually about as heavy as the one in this bridge, and as Spanish arches were seldom of a much greater span, the reason that the Spaniards found it impossible to bridge any but the small or

very sluggish streams is evident. In fact, their extreme limitation in this regard is shown by the fact that they left only four multiple-arch structures, with an aggregate of twelve spans, in the whole of Bulacan Province. The longest arch of the twelve has a span of less than 8 meters.

To add to their difficulties, the Spaniards apparently found the building of subaqueous foundations a serious problem, for they seem not only to have lacked pumps, but even to have been unfamiliar with the use of the pile driver. Even the simplest forms of the cofferdam, except possibly the earth dyke, seem not to have been used. As a result, excavations for foundations were usually carried down to only about 3 feet below low-water level. It may be, however, that the Spaniard saw no need for going deeper than this, for there is no evidence of any very serious effort to go lower even where it would have been easy to do so.

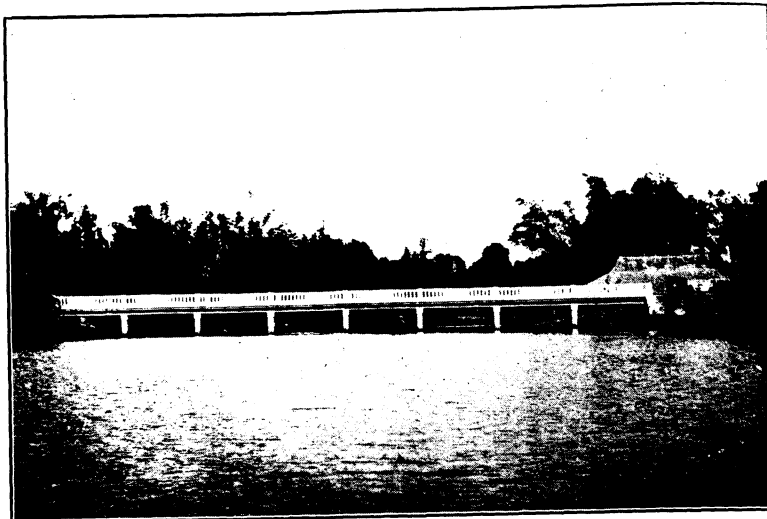
The excavation having been completed, it was filled with large stones, as carefully placed as possible. In case the water was so deep that no excavation could be made, stone was simply piled on the stream bed until it came almost to the surface of the water. Usually there is no evidence of the use of mortar to bind these stones together, but occasionally one sees a bridge where some mortar was used. Hydraulic cement of an inferior grade has been known and used for a long time, and it seems that at least some of those responsible for Philippine bridge construction should have known something of its manufacture and use. Perhaps the cost of importation from Europe prohibited its use.

The cut-stone courses were started from just below low-water level, and the masonry appeared to be run up a short distance and allowed to stand for awhile. A structure so begun was often years in progressing to a stage where the arch ring could be built, so that the settlement had usually stopped before the arch ring was constructed. It is reported that the Meycauayan Bridge was built in this way, and it is said to have been under construction for more than ten years.

From all this it should be clear that, though the Spaniards occupied these Islands for about three hundred years, the number of public works left by them is limited, and even those which they did leave lack much of conforming to modern ideas. It is perhaps proper to state that the Spanish engineers of that time did not have Portland cement as readily available as the present régime, nor had the use of reinforced concrete become adopted in general. Nowhere is the purpose of a government more clearly shown than in the nature and extent of its public works. Spain's religious ambitions are indicated by the

more modern can probably be laid to the fact that it had always been ample for such military needs as had arisen.

As contrasted with this policy, such public works as have been undertaken since the establishment of the present civil government have had as their aim the improvement of the economic and social

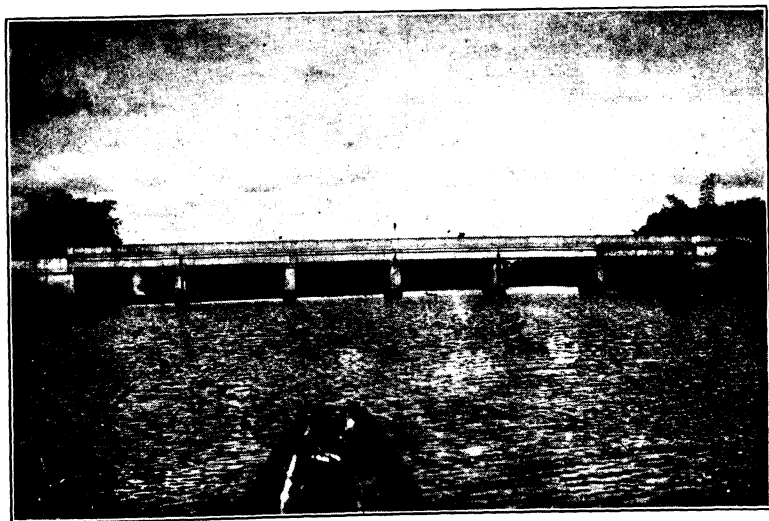


Guiguinto Bridge, Bocaue, Bulacan Province.

conditions of the whole people. To this end the first problem attacked was the construction of roads. Bulacan, in common with other provinces of the Philippine Islands, is subject to a very heavy rainfall. Most of the province is low and poorly drained. The year is divided into a wet season and a dry season, and during the wet season there are long periods when a good deal of water falls every day. Under such conditions, if there is any considerable amount of traffic, earth roads become a series of deep mud holes through which nothing but a carabao can travel. The old Spanish roads had been almost wholly destroyed during the war, and even the reconstructions attempted by the military authorities had gone to pieces because of a lack of maintenance. The problem, therefore, was not one of making over an old system, for about all that was left of that was the right of way, but of building a new system that would carry heavy traffic under trying conditions.

The first roads constructed in this province were the cart roads needed to connect the outlying towns with the railroad. Many of these roads were rather simple affairs, the most common practice having been to throw up an embankment 20 to 50 centimeters high and 4 to 6 meters wide, and cover it with a layer of gravel. There was nothing very definite about the height or the width of the embankment. Where the engineer thought wise, or when he ran short of money, he cut it down or left it out entirely. Similarly, the width and the thickness of the metalling were subject to his whim and to the financial condition of the province. Such freedom of action sometimes gave reasonably good results, but more frequently the results were a decided disappointment, and after a short period of experimenting the work of the Bureau became more centralized, the powers of the field engineers were curtailed, standards of construction were brought out, and an effective system of maintenance was established.

About the time the change in road standards took place the province took up the question of constructing intermunicipal roads. These roads have all been built during the past five years and are of standard first-class construction. Naturally the road section used has varied, not only because of the unevenness of the country, but on account of other differences which have made alterations in the slope of the embankment, its average height, the thickness of the metalling, etc., advisable, but in general the first-class roads of Bulacan Province have a metalled surface that is 4 meters wide and 15 centimeters thick after rolling. The embankment is usually from 30 to 50 centimeters above the old ground level, and where the embankment is less than 60 centimeters high a 4 to 1 slope is used. The shoulders are usually 1 meter wide. The old idea seems to have been that a considerable crown was advisable on macadam and gravel roads,



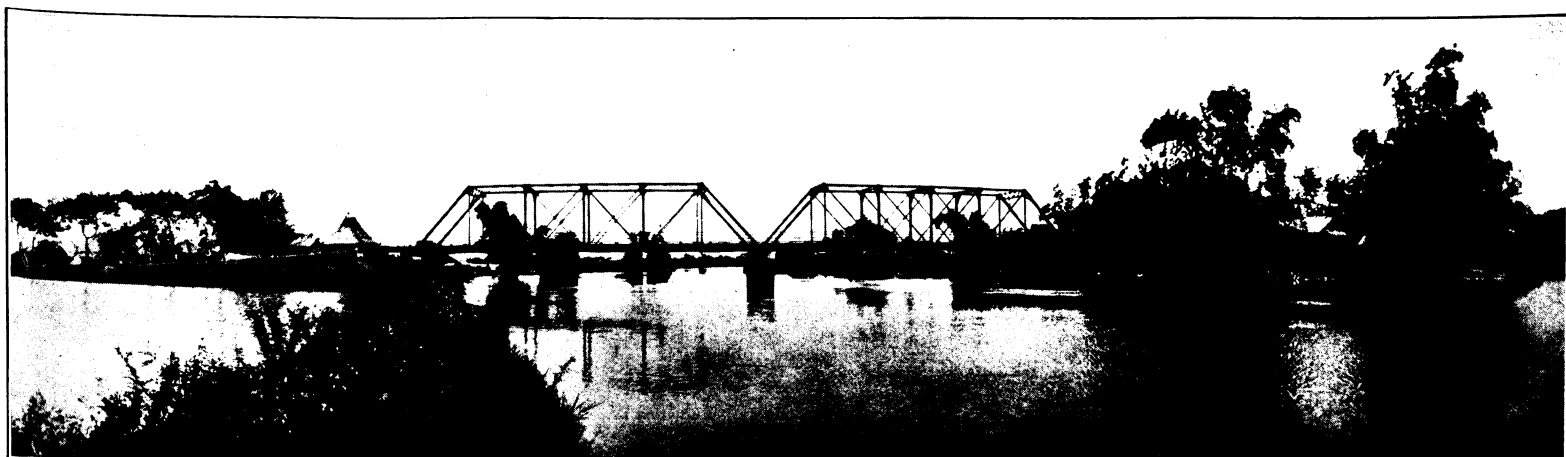
Bocaue Bridge, Bulacan Province, American construction, 12-meter slab and girder, standard piers and abutments.

fact that in every provincial town the largest building is the church. Her concept of the importance of adding dignity to the Government is seen in the municipal building which every municipality was required to provide. Her purpose to defend her title and to increase the stability of her control is shown by the fact that her road system was undoubtedly constructed for military purposes, and that it was no



but the present tendency is to reduce the crown to 6 or 7 centimeters. The shoulders are given a little more pitch than the metalling, and while the standard plans show a distinct break in pitch between the shoulders and the embankment slopes, no effort is made to maintain it.

gravel road had been built. Naturally much of this road was in isolated sections, and so was of little use to the people who did not actually live on it. When most of the outlying towns had been connected with the railroad, there naturally was a desire to make these isolated sections of road available to more of the people of the



Malomot Bridge, Bulacan Province.

The first-class roads are built of either gravel or broken stone laid in two or three courses and compacted by means of heavy rollers. The larger part of the traffic consist of light vehicles, though the cart traffic is considerable and at some seasons of the year is heavy. There has never been much automobile traffic, but recently it has been increasing very rapidly. So far the roads constructed as above described have proved satisfactory, but they are not built to carry heavy trucks, which, if they come into general use, will necessitate the employment of a thicker course of metalling.

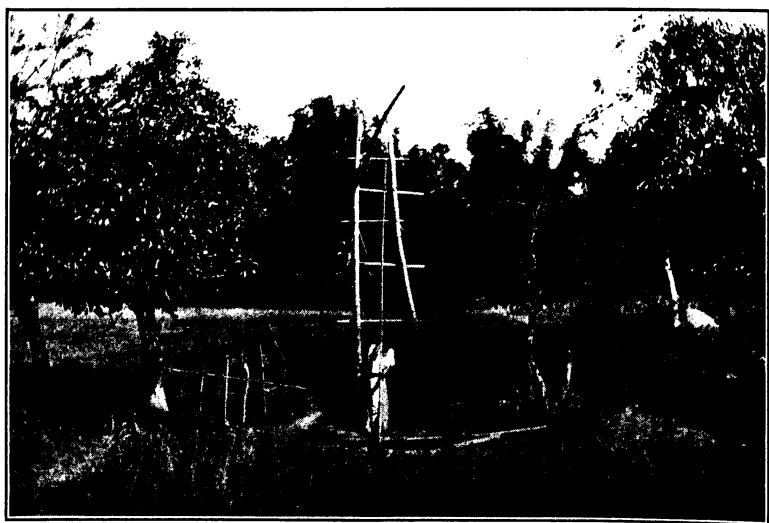
It early developed that, no matter how well built a road might be, it would fail rapidly if not given constant care. The surprisingly rapid disintegration of the military roads and the difficulties which early engineers experienced in building roads that would "stand up," can be almost wholly laid to the failure to take proper care of their completed structures. It is commonly supposed that road construction in the Tropics is peculiarly difficult. This is not at all the case, nor is road maintenance especially trying. It is true that the carrying capacity of subgrades is usually less than in countries where the rainfall is lighter, and that thicker metalling is therefore required to support the same loads, but if this difference is allowed for when a road is constructed, the road will probably last longer than a similar one built to carry the same traffic in the United States. As indicating the justice of this view it may be recorded that it is the dry season and not the wet season that the highway engineers of the Philippine Islands fear. Roads that are overloaded, and roads where potholes go without attention, fail with terrible rapidity during wet weather; but where a road has a factor of safety even approaching to that usually taken as a matter of course in a bridge, it should always come out of a wet season looking better than when it went in, while the reverse is true of even a moderately dry season.

The present system of roads is more or less an evolution, not only in construction and maintenance, but in location. Tourists landing for the first time in the Philippine Islands, and travelling from province to province over modern roads that now exist everywhere, often remark on the beautiful "automobile roads," as though they supposed that a beautiful pleasure system had been developed. Nothing could be farther from the fact. The road system is the result of careful planning and of a most conscientious effort to guard the interest of the public at large.

The growth of the system in Bulacan Province is typical of the manner in which the entire Insular road system has been developed. Starting from nothing, the early engineers built only cart roads connecting outlying towns with the railroad. Some of the early roads were too light, but as time passed this deficiency was remedied and within a few years considerably over 100 kilometers of very fair

province by building the intermunicipal roads necessary to connect the isolated stretches. Then, since the provincial system could be of little use to the people of other provinces unless it was joined to their systems, the Insular Government gave the money to connect the Bulacan system with the provincial systems to the south. Later, because the financial condition of this province did not permit the completion of some of its intermunicipal units as quickly as the needs of the provinces to the north seemed to require, the Insular Government gave liberally toward the construction of these roads, and also gave the money for connecting Bulacan Province with the northern provinces.

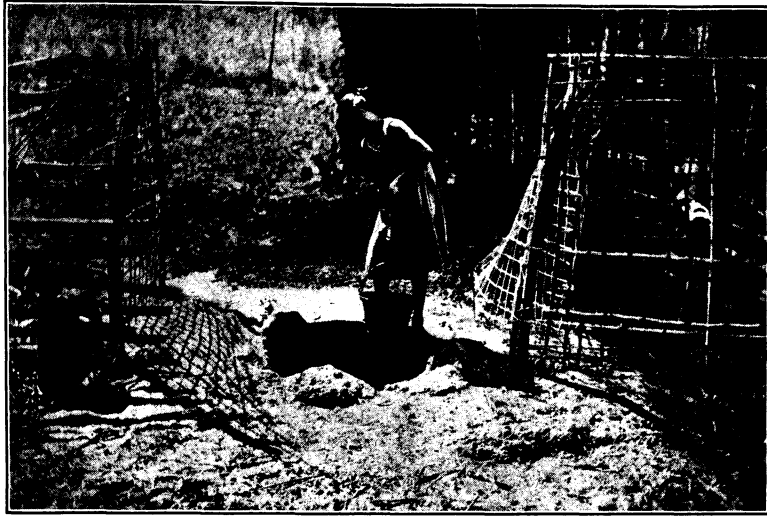
Bulacan now has 83 kilometers of first-class metalled highway and 102 kilometers of second-class metalled highway. These roads are open to all kinds of traffic at all times of the year. Of the 21 towns in the province 20 are reached by the road system, and are consequently accessible during all sorts of weather. The province is connected with the provinces north and south of it, and thus other provincial systems as large or larger than its own are opened to it. But though many automobiles use these roads, and though the whole



Uncurbed well, Bulacan Province.

system affords unusual pleasure to the enthusiastic tourist, it is not an automobile system. It is simply a well-constructed and a well-connected system of cart roads, built to facilitate the handling of the internal commerce of the country and to stimulate the social life of the common people.

The designing of all bridges and culverts is done in the central office of the Bureau of Public Works at Manila. Bridge design is, therefore, uniform all over the Islands, such differences in the prevailing type of structures as one sees in different provinces being due either to the different characteristics of country or streams, or to



Near San Miguel, Bulacan Province. Well lined with earthen tile curbing.

the personal preference of the field engineer and his desire to use some particular type of construction wherever possible. However, such personal preferences merely influence the choice between possible types without in any way affecting the fitness of the design.

A large part of Bulacan Province lies in the delta at the north end of Manila Bay. The number of streams that it has been found necessary to bridge has consequently been large, and as most of these streams are very sluggish, it has been possible to use bridges of comparatively short span. This has encouraged an extensive use of concrete, and, as steel rusts with surprising rapidity in this country, concrete was for some years specified even when it cost more than steel, because it was believed that the concrete would be more permanent, and it was known that it would cost less to maintain. Of recent years, however, the tendency has been rather reversed, for it has been found possible to maintain steel structures and there is beginning to be a little suspicion that the life of reinforced-concrete work in the warm humid atmosphere of the Philippine Islands will not be as great as had been expected.

Thus the early American bridges over the delta streams were most of them composed of 12-meter concrete slab-and-girder spans on concrete piers. A little later a few steel bridges erected on steel cylinders were designed for these streams. The concrete pile substructure has come into favor recently, and the structures designed for sluggish streams without drift are of 7-meter slab-girder spans on reinforced-concrete piles. This is the cheapest form of permanent bridge construction that has ever been tried in the Philippine Islands and is entirely satisfactory wherever proper penetration can be secured for the piles, and where the openings are not likely to be choked by heavy drift. A number of bridges of this type have been erected on the delta, and all of them give promise of proving very satisfactory.

In the rolling country between the delta and the foothills the stream velocities are greater and drift is a more serious problem. Moreover, the floods are higher in this region, because the streams are more nearly confined to their banks. The tendency has been to use steel spans for crossings in this rolling country, the reason undoubtedly to be found in the fact that as the amount of scour in some of these rivers is considerable, and as quite a little timber comes down with the higher floods, an unobstructed channel is much to be preferred to one broken by piers. Within the past two years, however, three bridges composed of standard 7 or 7.5 meter concrete slab-and-girder spans on concrete piles have been erected over rivers in the rolling country, one of these being a river of considerable size. Though

these structures have gone through two seasons without serious damage, it is feared that a sudden flood carrying brush and timber might cause trouble.

The erection of bridges is usually done by contract. In this respect it differs from road work, which is practically all done by forces in the employ of the district engineer. At best the contract system has never been very satisfactory in this province, and at present it seems to be giving way to administration work, which has been found to be cheaper as well as more reliable and generally of better quality.

Some idea of the extent of the work which has been done in the past ten years can be gained from the following brief summary of the permanent bridge structures in Bulacan Province. This summary does not include culverts (structures having a span 5 meters or less), as the date of the construction of many of the smaller culverts is unknown. However, it serves very well to show, not only the differences in general type between the structures erected in Spanish times and those erected now, but also the amount of work that has actually been accomplished since the American occupation.

	Left by Spaniards.		Built since establishment of civil government	
	Spans.	Length.	Spans.	Length.
		Meters.		Meters.
Arches <sup>a</sup> .....	17	119.1	1	15.1
Steel truss bridges.....	3	36	19	356.7
Steel I-beam concrete floors.....			<sup>b</sup> 17	104.1
Concrete bridges:				
Standard substructures.....			24	246.2
Concrete pile substructures.....			43	307
Total.....	20	155.1	104	1,209.4

<sup>a</sup> The Spanish arches are all cut-stone arches. The American arch is a reinforced-concrete arch.

<sup>b</sup> Four of these spans have wood floors.

In Spanish times educational matters were largely in the hands of the church, and in Bulacan Province no special buildings seem to have been erected for school purposes. Under the present régime an active educational program is being carried out, and standard school buildings are being erected as fast as the finances of the municipalities permit. These buildings are 1-story concrete structures, but because of their timber roof framing and wood floors are rated as only semipermanent. The municipalities of this province now have a number of these buildings and each year shows some additions.



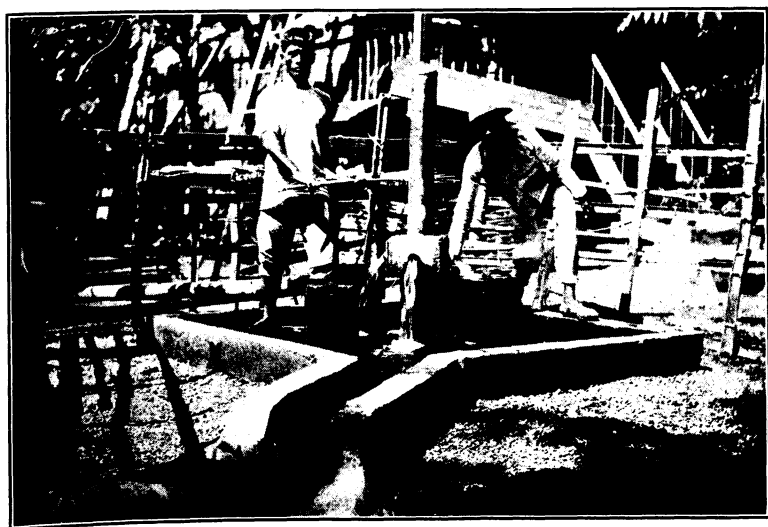
San Miguel, Bulacan Province, Spanish type square well, curbed with adobe stone.

One of the more recent efforts in behalf of the poorer classes has been the erection of modern sanitary markets in a large number of municipalities. The objects in view were three. In the first place, the small producer needed a location where he could, for a reasonable price, obtain space in which to expose his products for

sale. Before the new markets were erected it was often impossible for the fisherman with a few fish or the farmer with a little fruit or the weaver with a few bolts of cloth to dispose of his wares at a reasonable price, for the owners of the small native stores usually insisted on a wide margin of profit. Then, too, the public at large was inconvenienced because the stores handled local products only in very small quantities. Moreover, the people needed a clean, sanitary place in which to sell and buy. Epidemic diseases are common in the Philippines, and some of them can be carried on the food sold in the stores and markets. It was hoped that the new markets could be kept sufficiently clean so that at least some of the risk of spreading disease would be removed. Lastly, the municipalities needed more revenue. It was thought that they could borrow the money needed for the construction of new markets, pay it back out of the revenue that the new buildings would produce, and eventually have both the new buildings and an increased revenue. The receipts from the markets in Bulacan Province have certainly justified all of these assumptions.

The market buildings are simply large *camarines* (warehouses), with corrugated iron roofs supported on concrete columns, and concrete floors. They have been well patronized, for they are dry, clean, and comparatively cool. Due to the efforts of the provincial treasurer, Mr. Geo. P. Banner, modern markets have been erected in seven towns in this province.

Tropical countries are notoriously unhealthy. The Philippine Islands of fifteen years ago were no exception to this general rule, but an active health department has greatly reduced the death rate from epidemic diseases. One of the most potent factors in bringing about the improved health conditions of to-day has been the securing of a better water supply in Bulacan Province from artesian wells. In the lower part of the province there is a water-bearing stratum only about 60 meters below the surface, and as there is no hard stratum to penetrate, it is an easy matter to sink wells into this stratum by means of a light jet rig. The province owns a number of these jet rigs and they are kept steadily at work. When a locality desires a well it pays ₱70 (\$35) into the provincial treasury and furnishes all labor needed in drilling the well. As these localities are often very poor, the province furnishes the well rig and the services of a competent overseer who supervises the drilling, and pays all expenses for pipe, etc., above the ₱70 deposited. In this way nearly 200 wells have been sunk in Bulacan Province, most of them within the past five years. A few of these wells must be pumped, but most of them flow from 5 to 15 gallons a minute and a good one may flow as much as 30 to 40



Pulilan well (deep well), Bulacan Province.

gallons a minute. The people naturally prefer the fresh pure water from these wells to the water which can be secured either from the rivers or from open surface wells and, as it is free from disease germs, its use has greatly decreased the amount of cholera, dysentery, and other water-borne diseases.

The water-bearing stratum under Bulacan Province has a slope that appears to be quite different from the slope of the surface strata. Moreover, it does not seem to be uniformly porous, for different wells at the same distance above sea level act very differently. For instance, at Malolos and Meycauayan excellent flowing wells can be



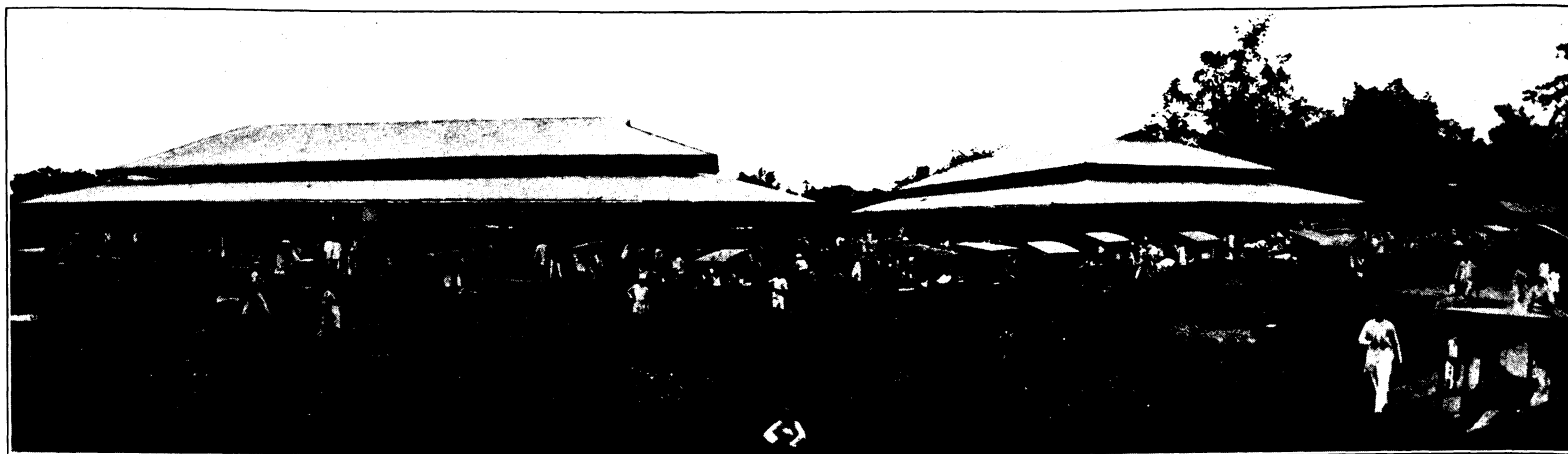
Near Malolos on Manila-North Road, Bulacan Province.

secured at a depth of 55 to 75 meters, while wells sunk to about the same depth in Bocaue, which is between Malolos and Meycauayan, or in Obando, which is just beyond Meycauayan and on the same delta, will pump almost any amount but do not flow. Moreover, the flow of wells within a few hundred yards of each other differs a great deal.

Sixteen kilometers back from the coast, though the country as a whole is probably not over 10 meters above sea level, the water-bearing stratum is 125 meters or more below the surface and, being under a number of hard strata, can be tapped only by means of a steam rig. This considerably increases the cost of wells and naturally limits the number that can be sunk. However, the municipality of Baliwag has been able to raise the money for nine of these wells and a number of municipalities have one or two of them.

At Santa Maria a well was sunk from one of the highest points in the town. The flow proved to be unusually strong, so the well was connected to pipes which carry the water all over the town and make it easily accessible to all of the people. Thus in one way and another and as rapidly as possible, a supply of pure, wholesome water is being developed. It is a slow process, for the country is far from being rich and revenues are anything but large, but the people like the better water so well that they go long distances to get it, a fact which makes each new well a distinct asset and greatly stimulates the demand for more wells.

Public improvements are paid for by the people, the funds being collected by the usual methods. The general system of taxation is modeled after the one in vogue in the United States. The Insular Government is supported chiefly by indirect taxes, such as the tariff on imports, the internal revenue, etc. Most of the provincial revenues are derived from very light cedula tax (poll tax) and a land tax, though a portion of the internal-revenue tax also goes toward the support of provincial and municipal activities. The municipalities are allowed by law a proportion of the internal-revenue tax, a proportion of the cedula tax, and are permitted to increase or decrease their share of the land tax within narrow limits. The municipalities also derive some of their revenue from licenses of various kinds and from the public markets. The law not only provides the sources of revenue but divides the collections into road and bridge funds, school funds, general funds, etc. General funds may be used for general purposes, or may be diverted to aid the special funds, but a special fund must be used for the purposes indicated in its name. Thus, schools are paid for out of the school funds, but markets and wells are financed out of surplus general funds. Roads and bridges are paid for out of the road and bridge fund, which in Bulacan Province amounts to about ₱110,000 a year. Of this about ₱62,000 is derived from the cedula tax (poll tax) of ₱2, one-half of which



Bulacan Market, Bulacan Province.

is credited to the provincial road and bridge fund. A land tax of one-eighth of 1 per cent yields about ₱24,000 annually, and the internal-revenue taxes about as much more. This is equivalent to a road tax of only about ₱1.75 (\$0.75) per man, certainly not an excessive amount.

Beside the regular provincial revenues, the Insular Government has for some years allotted funds to the provinces for road purposes. These allotments are known as regular allotments and special allotments, the regular allotments being distributed according to the population and the special allotments as an aid to special projects. The regular allotment for Bulacan Province has usually amounted to about ₱32,000. The special allotments vary, but in the long run should come to about the same amount. The Insular allotments are therefore equal to a road tax of approximately ₱1 per man. In other words, the funds which have been expended for roads and bridges in Bulacan Province represent an annual poll tax of only about ₱2.75 (\$1.375) per man. This is a very light tax, especially when compared with the Spanish requirement that each man work fifteen days on road and bridge work, a requirement that at the present price of labor would amount to a tax of about ₱10 (\$5) per man.

School buildings, markets, and wells are municipal undertakings and are all financed by the municipalities. The Insular Government aids in the erection of school buildings and in the sinking of deep wells, but the markets are paid for by the municipalities themselves

ten years. These loan funds have been used very freely to stimulate the construction of public works of all kinds, but Bulacan Province has availed herself of the use of such funds only for the construction of bridges and market buildings, the early completion of many of her most important bridges and the entire market program having been made possible by an extensive use of these funds. Of course, the repayment of the loans will cut down future construction work to some extent, but where money can be borrowed for the erection of structures that should have a life greatly in excess of the loan period, the fact that they can be made available to the public at an earlier date should be worth a great deal more than the interest on the money borrowed for their construction.

The road system of Bulacan Province is unusually compact and well connected. Very few bridges are lacking. Its municipalities are building good schools and good markets, and are beginning to consider seriously material improvements for their streets. In spite of the progress that has been made, however, much is still needed, and as the wealth of the country increases and the revenues are gradually raised, a great many public improvements which are now out of the question will become matters of necessity. The work done is not, therefore, a matter of pride because it has been completed, nor because a startling amount has been done, for there is still much to do. It is rather a matter of pride that, through effective organization and efficient leadership, so much has been done with so little money, and that the results justify the belief that the efforts to use public funds efficiently for the improvement of the economic welfare of the whole community have been a success.

## THE TAGBILARAN WATER SYSTEM.

By L. S. BOGCESS, C. E., District Engineer, Bohol Province.

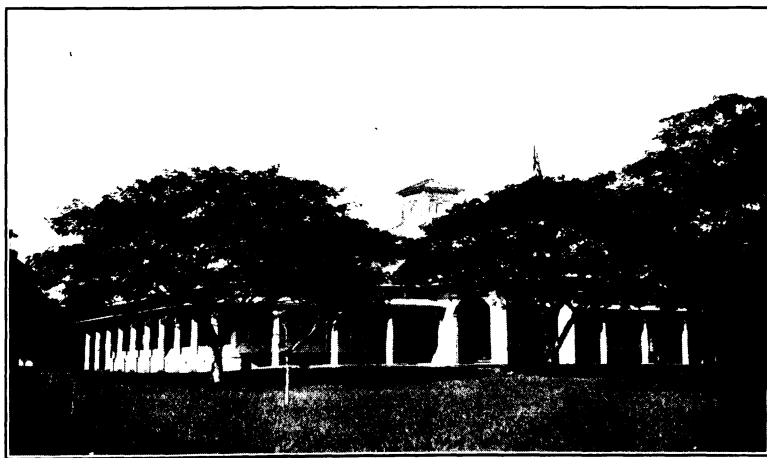
The construction of this system was begun by Mr. L. T. Clark in January, 1912, and had just been completed when the writer relieved Mr. Clark in January, 1913. An additional pumping outfit was installed in December, 1914 by the writer but the conditions under the original system are first discussed and a comparison of the pumping plants is shown herewith.

The water for the original pumping plant is furnished by a well drilled by the artesian well division of the Bureau—well No. 192—and is 680 feet deep, and when completed gave a flow of about 60 gallons per minute. The casing is 6 inches in diameter and the total cost of the well was ₱6,288.24.

This water is pumped to a concrete supply tank 7 meters in diameter and 4 meters high, having a capacity of 40,000 gallons. Plan of tank is shown herewith.

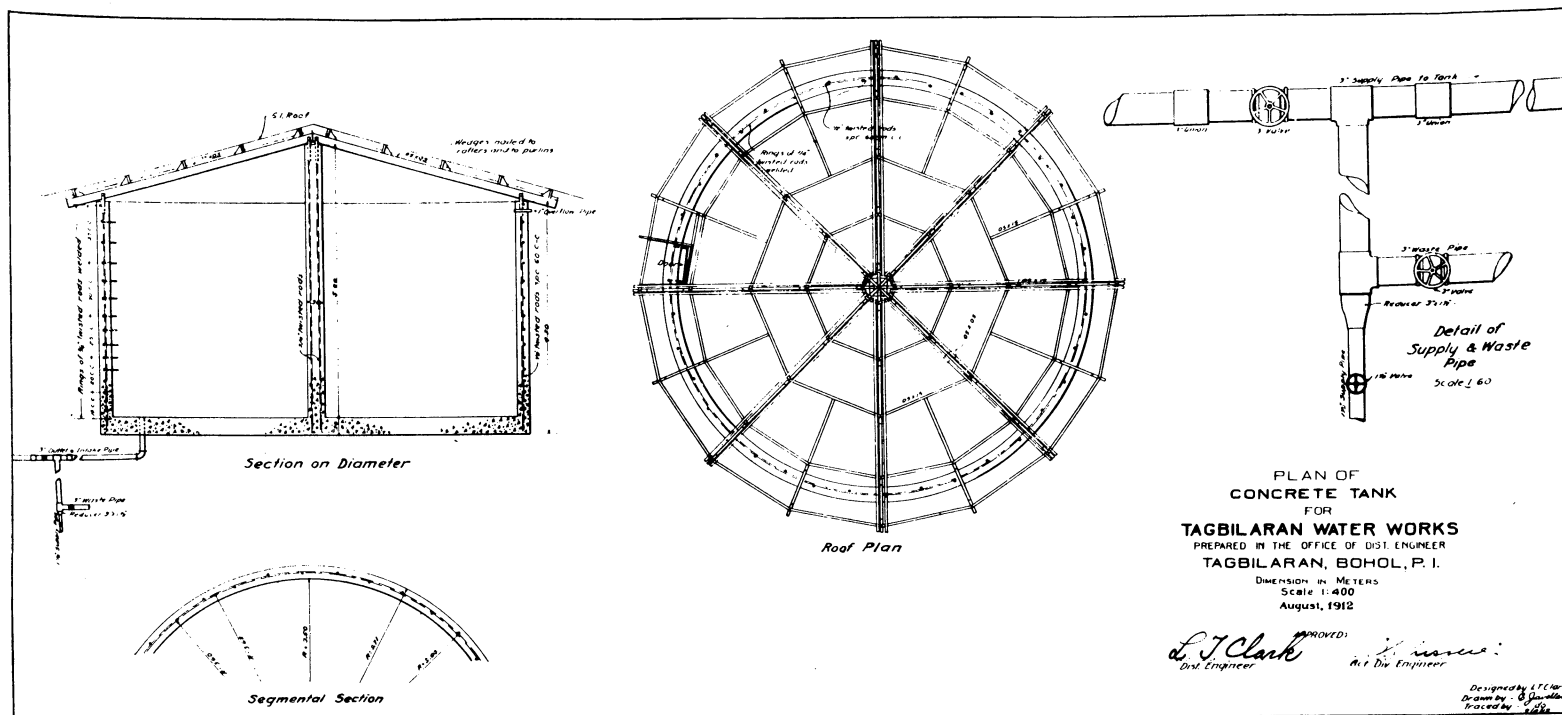
This tank is filled by the old pumping plant, pumping seven hours daily for three days, water being consumed at the same time.

The following is a copy of the analysis of this water by the Bureau of Science:



The provincial building of Bulacan Province.

out of their regular incomes. Municipalities and provinces cannot sell bonds, but the Insular Government has funds, as for instance the savings bank deposits, which it loans to provinces and to municipalities. The money borrowed from these funds is repaid in regular installments and the whole loan must usually be canceled within



# CHEMICAL ANALYSIS.

[December 28, 1910.]

Physical characters.....	Good.
Reaction.....	Alkaline.
Total solids.....	2,547.8
(a) Fixed.....	2,331.3
(b) Volatile.....	216.5
Appearance on ignition.....	Darkened slightly.
Free or saline ammonia.....	0.0096
Organic or albuminoid ammonia.....	0.0048
Oxygen consumed..... (Schulze troms).....	0.48
Chlorine.....	1,099.5
Nitrogen as nitrates.....	Traces.
Nitrogen as nitrites.....	Nil.
Nonscale-forming ingredients.....	1,825.0
Scale-forming ingredients.....	506.0
Silica (SiO <sub>2</sub> ).....	43.1
Oxides of iron and aluminum.....	1.2
Oxide of calcium (CaO).....	179.1
Oxide of magnesium (MgO).....	150.7
Sulphuric anhydride (SO <sub>3</sub> ).....	397.0

# BIOLOGICAL REPORT.

[November 1, 1910.]

Ciliates.....	Negative.
Pathogenic bacteria.....	Negative.
Negative for B. Coli communis.....	
Amoebae.....	Positive.
Flagellates.....	Positive.

The percentage of solids is six times that adopted by sanitary authorities for potable water and the percentage of chlorine twenty-five times, and the hardness is much greater than adopted standards. It was the opinion of the Assistant Director of Health that these conditions would better themselves after the water had flowed a sufficient time. This was found to be true and a copy of a new analysis is here given.

Water sample from well No. 192 at Tagbilaran, Bohol, No. 2.

# CHEMICAL ANALYSIS.

[March 26, 1914.]

Reaction.....	Neutral.
Total solids.....	240.0
Appearance on ignition.....	No odor.
Free or saline ammonia.....	0.024
Organic or albuminoid ammonia.....	0.014
Chlorine.....	3.26
Nitrogen as nitrates.....	Traces.
Nitrogen as nitrites.....	Traces.
Silica (SiO <sub>2</sub> ).....	97.7
Oxides of iron and aluminum.....	7.7
Oxide of calcium (CaO).....	31.7
Oxide of magnesium (MgO).....	10.00
Sulphuric anhydride (SO <sub>3</sub> ).....	22.5

Remarks.—This water is satisfactory for drinking.

# BIOLOGICAL EXAMINATION.

[March 25, 1914.]

Number of colonies per cubic centimeter.....	2,353
Presumptive test.....	Positive.
Attempt to isolate B. coli.....	Negative.
Amoebae.....	Negative.
Ciliates.....	Negative.
Flagellates.....	Negative.

The tank when first filled developed wet places on the outside due to seepage at joints. One year later the seepage had practically ceased, leaving a salt deposit on the outside of the tank. This deposit is due to the amount of solids in the water.

This tank has since been painted a cream color with "Stonetex," recommended by the Trus Con Laboratories; seepage having completely ceased, the inside of the tank required no further waterproofing. It was contemplated that it would require waterproofing and a trial of Trus Con waterproofing paste was to have been made.

The painting with "Stonetex" has not been entirely satisfactory, but the appearance of the tank is improved to a certain extent, and by the addition of another coat of paint the white deposits may be made invisible. The deposits were scraped off before the paint was applied.

Map of Tagbilaran appears herewith showing complete pipe line and all public hydrants. The main line from well to tank is 3 inches in diameter with branch lines 1½ inches in diameter. Distance from well to tank is 860 meters. Lift is from 12.50 to 16.50 meters, the intake being in the bottom of the tank.

Water is pumped by a Fairbanks-Morse kerosene pumping engine, 8 horsepower, with a 4-inch intake and a 3-inch discharge. Cost of engine, ₱1,950.29.

At first the use of this machine was not very successful, due to lack of experience with this kind of an internal-combustion engine. However, during the last nine months that this pumping plant was operated, very little trouble has been encountered in the operation of the engine.

Total cost of the installation of pipes and tank as shown by the drawing appearing herewith was ₱12,195.07. This does not include cost of pumping plants which are listed separately. There are now in use 9 public and 65 private hydrants, all with ½-inch compression bibbs. There are also 4 other hydrants for official use.

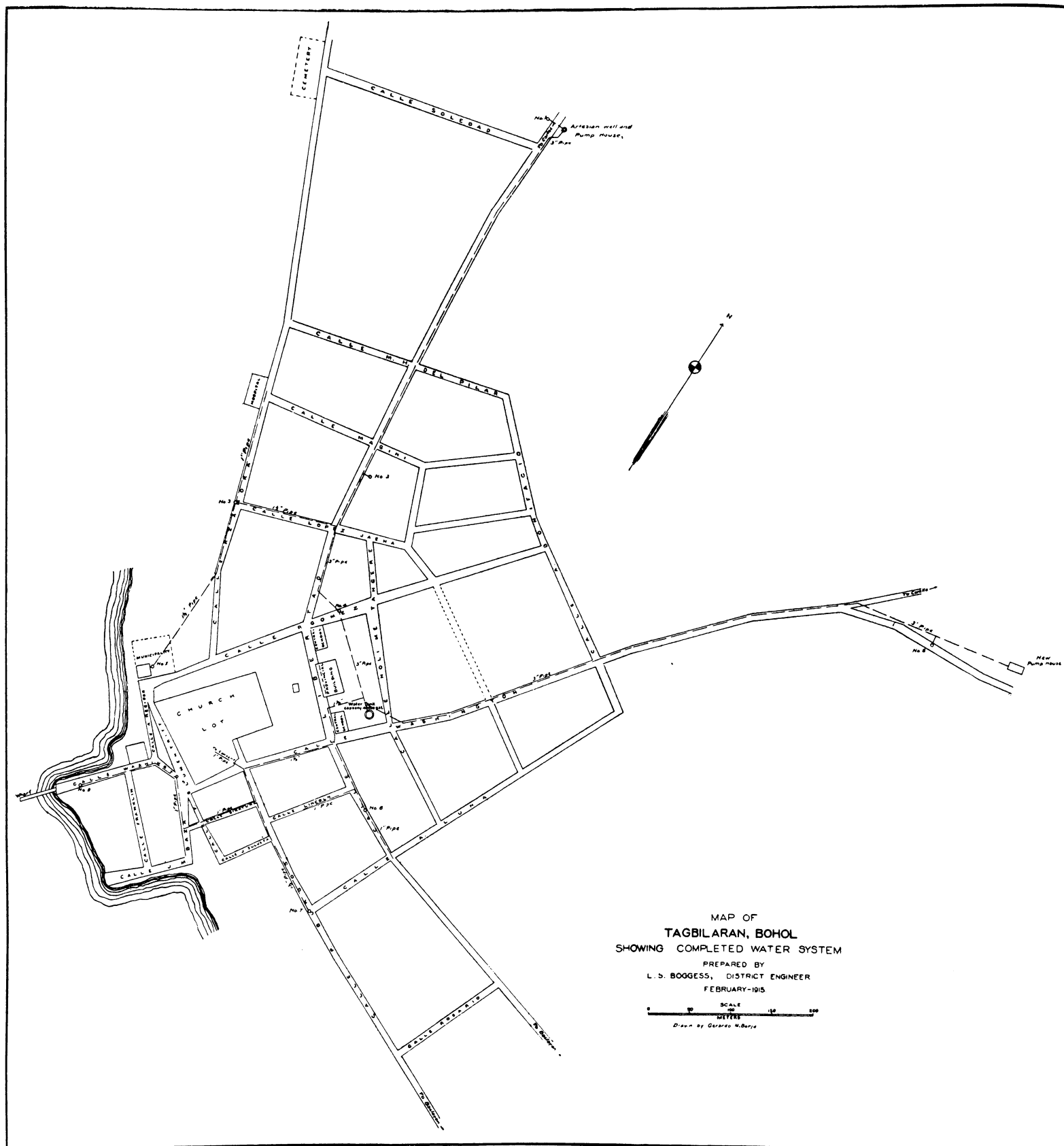
At one time, the artesian well became bridged over to such an extent that the water would not rise fast enough for the pump. It was found necessary to have it cleaned out and a pocket drilled below the water-bearing stratum. This was done by one of the Bureau



deep-well rigs, and it is believed that no further trouble of this character will arise.

However, early in the year 1914 a new well was drilled back of

The distance from the surface to the well is 100 feet, therefore a deep-well pump was ordered from the United States. This is a Gould deep-well pumping outfit and is illustrated herewith. The



Tagbilaran in an effort to obtain better water than that being pumped into the system at that time. This well was successful. The distance from the tank is 840 meters and the cost of the pipe line to this well is included in the above-mentioned cost of system. The well is 126 feet deep.

water is being lifted 112 feet. The cylinder in use is 5½ by 24 inches. Wooden sucker rods and 6-inch suction pipe are used. The cost of this pumping outfit is ₱946.87. A Mietz and Weiss kerosene engine, 4 horsepower, was purchased to operate this plant and has given perfect results. The cost of engine was ₱772.06.

The water from this well is much better than that from the old one, the private connections increasing from 28 to 65 in less than three months. A copy of the analysis of this water is here given.

*Chemical analysis and biological examination.*

[Sample from well No. 619 located at Tagbilaran, Bohol, No. 3. Received, April 20, 1914. Laboratory No. 118556.]

CHEMICAL ANALYSIS.

[April 30, 1914. Numbers give parts per million.]

Physical character .....	(*)
Reaction .....	Neutral.
Total solids .....	418.0
Appearance on ignition .....	(b)
Free or saline ammonia.....	0.398
Organic or albuminoid ammonia.....	0.301
Chlorine .....	42.23
Nitrogen as nitrates.....	Little.
Nitrogen as nitrites.....	Nil.
Silica (SiO <sub>2</sub> ) .....	13.7
Oxides of iron and aluminum.....	1.3
Oxide of calcium (CaO).....	132.1
Oxide of magnesium (MgO).....	7.8
Sulphuric anhydride (SO <sub>3</sub> ) .....	6.0

\* Sulphurated and contains some sediment.      b Smell of organic substance.

BIOLOGICAL REPORT.

[April 25, 1915.]

Colonies per cubic centimeter.....	29,765
Presumptive test .....	Positive.
Amoebae .....	Negative.
Flagellates .....	Negative.
Ciliates .....	Negative.
Attempt to isolate B. coli: A bacterium of the coli group was isolated from this sample of water.	

At present, it is necessary to pump about 45 cubic meters per day only and it is proposed to lay a 2-inch pipe line to Dausi, a neighboring town which has no water supply for any kind. The distance is 3 kilometers and the flow will only be 10 gallons per minute, but a small storage tank will take care of the rush period. This will cost the town of Dausi about ₱2,500 and the writer has been working up the project and it is probable that the necessary money will be obtained some time this year.

The two men operating the pumping plant are busy for about three hours daily, as only 45 cubic meters of water daily are now required. The addition of Dausi to the system will occasion no additional labor cost for the operation, but should materially reduce the unit cost per meter pumped.

The following operation costs are here given:

	Pumping plant.	
	Old.	New.
Labor .....	₱159.97	₱140.00
Fuel, oil, etc.....	246.19	88.06
Total operation cost.....	₱406.16	₱228.06
Hours operated.....	517.50	178.00
Cubic meters pumped.....	2,765.00	2,531.00
Unit cost per hour .....	₱0.785	₱1.28
Unit cost per cubic meter.....	₱0.147	₱0.09
Cubic meters per hour .....	5.34	14.20

Cost of fuel for operating the new plant for six days while cleaning out the well is included in the above.

If an additional demand of 40 cubic meters daily can be created, the cost per cubic meter can be materially reduced and the demand can still be easily taken care of.

From the above costs it may be seen that the cost per hour operated is more on the new plant than the old one; but the amount pumped per hour is increased almost three times. The old plant, consisting of a suction pump only, did not receive enough water at the end of the pipe to do efficient work. As the water was pumped out the flow in the well was not enough to supply the pump. In the new system, the measured output is almost exactly the same as the amount calculated for the pump running at a standard speed of 24 strokes per minute. The new well has shown absolutely no sign of failure. The output is the same the last hour operated as the first.

All the water going into the system is measured through a meter and it is desired to meter all house connections also. At present, 36 house connections have been metered. These prevent waste of water and obtain larger revenue for the system. After all private connections are metered, the amount of free water used can be determined.

ON THE JOB HERE AND THERE.

Mr. E. J. Westerhouse, chief constructing engineer of the Bureau, left for a vacation in the United States on March 1, 1915. Mr. Westerhouse intends to devote practically all his time in the United States to travel and to investigating public works of all descriptions, and especially highway and bridge construction, and concrete structures of all sorts and types. He plans to tour to a large extent the proposed Lincoln National Highway System.

Mr. R. K. West, one of our old employees who left the Philippines some years ago, is principal assistant engineer to the division engineer of division 4 of the California Highway Commission. Mr. West's headquarters are in San Francisco.

Mr. Rossiter Magers McCrone, formerly principal assistant engineer to the chief engineer of the Moro Province, is in Bangkok, Siam, as assistant engineer, irrigation branch, ministry of agriculture, of Siam. Mr. McCrone is at present in charge of the preparation of the general scheme for irrigating and draining a large area in the delta of the Menan River.

Mr. W. L. Gorton, formerly chief designing engineer of this Bureau, is now engaged on irrigation works in California.

Mr. C. W. Hubbell, at one time chief engineer of the Bureau of Public Works, is at present occupied on large municipal public works in Detroit, Michigan.

PROJECT NOTES FROM DISTRICT ENGINEERS.

ALBAY.

An artesian well, 485 feet deep, with a flow of 30 gallons per minute, has been completed recently upon the market site of Tabaco.

The Oas market, a 21 by 43.5 meter, type A market building, has been completed by administration at the following cost:

Miscellaneous (surveys, grading, supervision, etc.).....	₱731.03
Labor .....	3,804.44
Materials .....	8,204.65
Surcharges .....	1,839.77
Outstanding obligations .....	51.42
Total .....	14,631.31

The Camalig market, a standard 18 by 34 meter, type A market, has been completed at a cost of approximately ₱10,574.84. The work was also done by administration.

Work upon the Guinobatan-Jovellar Bridges is proceeding rather slowly on account of the delay in procuring materials and plans for the bridges. The entire work, for which ₱95,000 is available, is as follows:

- Bridge No. 8.1, a 6 meter reinforced-concrete arch (under construction).
- Bridge No. 9.4 a 6 meter reinforce-concrete arch (under construction).
- Culvert No. 9.9, a 2 by 2.5 by 11 meter reinforced-concrete box (under construction).
- Bridge No. 12.7, a 10.5-meter reinforced-concrete arch (plans not yet received).
- Bridge No. 13.6, a 120-foot steel truss (plans not yet received).
- Culvert No. 13.97, a 3 by 3 by 15 meter reinforced-concrete box (completed).
- Culvert No. 14.37, a 3 by 3 by 12 meter reinforced-concrete box (completed).
- Culvert No. 14.49, a 0.5 by 0.5 by 11 meter reinforced-concrete box (completed).

The cost of these bridges will be high on account of the difficulties of transportation and the depth of the streams crossed. The culverts will all carry high fills which necessitate a greater length to carry the slopes. Also, it has been impossible to secure good sand which has necessitated the use of an excess of cement. The work is being done by administration.

A loan of ₱25,000 has recently been received for the construction of a bridge across the Quinaly River between Polangui and Libon. The plans call for seven 9-meter spans on concrete piles, using precast girders; ₱30,000 is available for the work.

Two road rollers are now at work on resurfacing, one between Dagara and Guinobatan and the other between Malilipot and Tabaco.

## AMBOS CAMARINES.

The Manila Railroad Company will complete their bridge over the Argos River within the next few days, and then the road will be opened for general service from Legaspi to Iriga. Iriga produces about 75 per cent of the abaca and copra shipped from Naga to Manila, and freight will be shipped by rail to Legaspi and by boat to Manila, representing a reduced rate, as well as saving from three to five days on a shipment.

The row of 12 double 4 by 6 meter tiendas at Iriga was opened April 1. The demand is sufficient to fill all of them at a rental rate that guarantees a fair percentage of gain. Iriga has a popular market, which popularity will improve when the town is connected by rail with Tabaco and Legaspi.

A standard, type A, 21 by 36.10 meter market is under construction at Naga, the columns and framework being complete. Delay in the receipt of material will prevent opening the building on time. The duplicate building occupied November 1 is insufficient in size, and therefore the necessity for the additional structure to provide for the increase in the marketing activities.

The regular allotment of ₱50,173 was placed on the Tigaon-Pili Road to be used for road construction only. A requested loan of ₱150,000 is intended for bridge and culvert construction. The entire length of this road is 26 kilometers, 5 kilometers of which were constructed last year at a cost of ₱18,000.

The site has been surveyed for the Daet market. It is centrally located and expropriation proceedings were necessary to secure the land. Authority has been given to advertise for proposals for the construction of a standard, type B market building 21.0 by 43.50 meters.

During the past quarter the maintenance force on the Naga-Boundary Road has been resurfacing kilometers 8-19, inclusive, and reconstructing kilometers 29, 30, 32, and 37. The drought of the past five months completely disintegrated several kilometers constructed of volcanic ash. Maintenance material has been prepared for all first-class roads. Trees planted along the road are growing nicely, many of which, in two years more, will be sufficiently large to protect the road during the dry season.

Gang maintenance on the Goa-Tigaon-Guijalo-Carmoan Road, and the Pamplona-Pasacao Road will be continued during the year.

The subgrade has been completed on the Daet-Mercedes Road. Many sections of the earthwork were 2.5 to 3 meters in depth and extended the full width of the road for distances of from 350 to 500 meters. Earth necessary for the entire fill was obtained from borrow pits, which pits were donated by the property owners along the road. Cart traffic is allowed upon the road to compact the fill—200 to 300 carts passing daily. Stone for the surfacing was obtained by blasting large boulders located upon the opposite side of the river from Mercedes, and broken stone was delivered by bancas upon the Mercedes shore for 20 centavos per cubic meter. No surfacing has been placed, as it is desired to have the necessary amount of stone for the entire road deposited upon the shoulders before traffic is turned off the road. The road construction will include about ₱15,000 of bridge and culvert funds. The entire road will be completed July 1.

Bids were advertised for the construction of the Daet Central School January 11-25, 1915. As no favorable bids were received, the construction of the building was authorized by administration. The building will be a standard plan No. 7, and it will be located upon the Daet-Basud Road about 500 meters from the plaza.

The concrete abutments for the Balos River Bridge have been completed, and the false work has been placed for the erection of the steel span. Work is now suspended awaiting arrival of the fabricated material.

## ANTIQUE.

Gang maintenance of the second-class roads has been started early this year in order to give employment to a number of men whose crops failed on account of the drought which prevailed last year.

The construction of the San Jose-North Road has reached kilometer 28. Labor is rather scarce. Men have gone to Negros to work in the sugar mills and those who are in Antique are busy milling whatever sugar they grew last year. Construction is now involving heavy cutting and the use of dynamite.

Another problem which the district engineer meets every day is the number of persons who recommend themselves to be capataces. To meet the situation, the district engineer selects the most likely candidate and appoints him a capataz on condition that he bring in 10 laborers. He is paid 80 centavos a day for the 10 men that he brings in and 70 centavos if he brings only 8, or else he is not employed at all. If he brings 15 men he is paid ₱1.20 a day. This method is working well so far.

The construction of the San Jose-South Road has been practically stopped on account of a lack of funds. However, about ₱800 from

the second-class road maintenance has been used on constructing about 500 meters of the road along the line where the approved survey should pass with the approved cross section so that it will be necessary only to surface this section in order to make it first class as soon as the necessary funds are available.

A survey has been made of the Pandan Boundary-Interprovincial Road to Capiz, and if the plans and profiles are approved, a cart road will be constructed which will be converted into a first-class road in the future.

A survey has also been started of the Bugason-Lauaan Road which is the continuation of the San Jose-North Road system. This section of the road will follow the general course of the old Spanish road which is a good passable road during the dry season. The alignment is good and the subgrade is fairly hard.

The present school accommodations in the municipality of Culasi are very inadequate. Culasi is 84 kilometers from San Jose with only 22 kilometers of first-class road between and transportation is very poor. The municipality has secured a loan of ₱10,000, but this sum proved to be insufficient to construct a standard No. 7 plan building. The inhabitants, noting their need, promised to raise ₱1,000 by popular subscription, to furnish all the necessary sand and gravel, and further agreed to unload the materials from the steamer and carry same to the school site. It is hoped this project will go through this year, because if this school cannot be constructed a number of pupils will have to be deprived of instruction of order to make room for others.

Antique has been favored with ₱27,985 from the regular allotments, and this sum will be used mainly on road construction. A recommendation has been made requesting that part of this money be employed on the preliminary investigations and survey of the Iloilo-Antique-Interprovincial Road.

Very few steamers call at San Jose, the capital of Antique, and none of these ever appear during the southern monsoon. The connection between Antique and Iloilo by land will be the only way to solve the problem of transportation from Antique throughout the year. The length of this proposed road from the present provincial first-class road of Antique to the boundary is approximately only 8 kilometers, and if constructed its value to Antique would be unquestionable. At present quite a number of pedestrians are using the road to go from Iloilo to Sibalom on market days. Also those of Antique who go to attend the market in Oton, Iloilo, pass over the same road. This interprovincial intercourse is sure to be more developed if a good road is constructed.

## BATAAN.

The construction of the Balanga-South Road has been completed to the town of Pilar, and the other sections on kilometers 5, 6, and 7 are also under construction, the grading of which has now reached beyond kilometer 6. The gang moving the houses in the barrio of Santo Domingo between kilometer 6 and 7 is also nearing the completion of removing the nipa houses to the border of the 15-meter right of way. The hand-broken rock for this road is to be moved in bancas from the banks of the Pandan River, a distance of about 4 kilometers, and then is to be deposited in the barrio of Caluñgusan where it will be hauled in bull carts to the roadside at a maximum distance of 1.5 kilometers. About 300 cubic meters of stone have already been broken, and as soon as sufficient amounts are deposited at the sites mentioned, the surfacing will be started.

The construction of the Balanga-Puerto Rivas Road is in progress, and 1 kilometer has been surfaced with the first course consisting of "niggerheads." The broken stone, which is to be used in the second course, is deposited in various places near the bank of the Talisay River, and it is intended to begin to haul it to the road shortly. The grading of the road is completed with the exception of a little fill upon one of the curves.

The construction of the Orion-Limay Road was started in the beginning of March, and so far the progress has been good. It appears as though a complete relocation in the mountainous part is needed in order to obtain good grades and alignments.

A temporary wooden foot bridge is under construction between Mariveles and Cabcanan to span the Panikian stream. The opening of the bridge, with the rearrangement of the trails between the two places will, no doubt, be a benefit to the community.

The survey for the Orani market site is now completed and negotiations are under way for the immediate construction of a standard market in that town. The sum of ₱3,000 has been deposited with the provincial treasurer, and with an expected loan of ₱12,000 it is hoped that, in the near future, this town may have a modern market building. Other municipalities are following the lead of Orani and have requested that surveys of several market sites be made. It is hoped that, as soon as the pending road and bridge surveys are accomplished, the market site surveys may be completed.

# BATANGAS.

Owing to lack of funds, construction work on both the Tuy-Nasugbu and Ibaan-Rosario Roads has been temporarily discontinued. Work on the Ibaan-Rosario Road will, however, be immediately reopened as soon as the regular allotment of ₱53,930 becomes available.

A standard No. 2 school building was completed at Mataasna-ahoy by administration on March 24, 1915. The Tuy No. 4 school building under construction by contract is progressing slowly owing to delays in delivering materials.

The municipalities of Balayan and Batangas have requested plans and estimates for waterworks systems. The system of the former is to be supplied by a 40,000-gallon reinforced-concrete storage tank installed at the Balayan artesian well No. 2; the system of the latter is to be connected with the provincial pumping and storage plant. A request has also been received from the municipality of Cuenca for a preliminary investigation of certain springs with a view of piping the water to the town.

A 30 by 43.5 meter "no court type" market building was completed at Tanauan by administration on February 22, 1915, with a considerable balance remaining to the credit of the project, which is to be expended in grading and fencing the site and installing sanitary market tables. A 24 by 68.7 meter, type B, market building is at present in course of construction at Batangas by administration, and a 21 by 39.8 meter building of the same type is to be immediately undertaken by administration at Lemery. The Santo Tomas market, a standard 15 by 43 meter building, is at present being advertised.

Authority has been received for the reconstruction and repair of the Calumpang dikes No. 3 and No. 4. In 1911 five Neal system brush dikes were constructed in the Calumpang River at Batangas by the irrigation division of the Bureau of Public Works to prevent further encroachment of the river upon the town. In 1913, dikes No. 3 and No. 4, having been injured by the scouring action of the river, were strengthened by additional coral rock fill covered with galvanized-wire fencing, and the addition of reinforce-concrete terminals founded on piles and filled with adobe rock. The excessive floods of September, 1914, however, washed away several hundred cubic meters of rock behind the terminals of these dikes as well as most of the riprapping around the base of the terminals. Besides the reconstruction of those portions washed out, the present scheme of repairs contemplates the laying of blocks of concrete, each weighing about 600 kilos, around the terminals and on the back faces of the dikes and on portions of the river bed back of the dikes. These blocks are designed to be 12 centimeters thick, 110 centimeters wide in the direction of the current, and 150 centimeters long transverse to the direction of the current. Transverse to the direction of the current a strip of wire-mesh reinforcement is run through the center of the blocks, and instead of cutting this reinforcing at the ends of the blocks it is bent U-shape between them to allow for settlement. In the direction of the current continuous ½-inch square twisted bars are likewise run through the center of the blocks with a U-shaped bend between blocks. In case of settlement, this reinforcing can straighten out permitting a fair amount of settlement to take place. This work is being rushed in order that it may be completed during the present dry season.

A standard scheme A presidencia building was completed at Lemery March 6, 1915, with the exception of certain door and window fixtures which it was necessary to import from the United States and which have not as yet been received. The building is a 2-story concrete structure with open vestibule, the roof of which is supported by two circular concrete pillars of 70 centimeters diameter. The floors and stairway are of concrete and the treasurer's office is provided with a reinforced-concrete vault. Ample office space is provided for all municipal officials as well as a large session hall, municipal jail, store-room, fire department room, and kitchen. The parking of the grounds, including an extensive system of concrete walks and curbing, is now under way, which, when completed, will add greatly to the imposing appearance of the building.

# BENGUET.

Traffic over the Baguio-Bauang Road has been increasing very noticeably since the completion of the grading work December 23, 1914. The surfacing on the mountain section will be continuous by the end of March. Two private auto lines are operating a freight and passenger service over the road and many of the tourists to Baguio make the return trip to Manila via this route.

The Benguet Road has been maintained from tolls collected on traffic since January 1, 1915, when the funds appropriated for the maintenance of this road were exhausted. Temporary repairs have been made on a number of the structures during the past three months and the roadbed is also in good condition. Receipts from the toll on traffic will be sufficient to maintain the road during the present dry season.

Work on the construction of an addition to the Hotel Pines was completed March 16, 1915.

A rock-crusher plant was installed by the city of Baguio during January, 1915, to provide stone for the maintenance and construction of city roads. The plant consists of a No. 4 Champion crusher, jaw type, a 20-horsepower engine for operation of the crusher, a 60-horsepower hoisting engine for hauling rock from quarry to crusher, a 30-horsepower boiler for operating both engines, tramway track to quarry, 250 meters from crusher, and tramway cars to haul stone to the crusher and material from the crusher to the loading bins. The quarry is located on the side of a deep basin where a road would not be feasible on account of the basin holding water during the rainy season. The crusher stands a short distance below the Manila Railway Company's proposed freight station and the city storehouse and the material from the quarry has to be hauled up about a 20 per cent grade. Two 1-meter cars are hauled each trip, the boiler furnishing sufficient steam for operating both engines at the same time. Stone is quarried and placed in cars by contract at ₱0.85 per cubic meter. The cost of crushing and placing in loading bins has averaged about ₱0.30. The quarry contains an unlimited supply of a good quality of limestone for all purposes for an indefinite period. The plant has a capacity of about 60 cubic meters per day and about 8,000 cubic meters of material of all classes will be required for road work in the city during the present year.

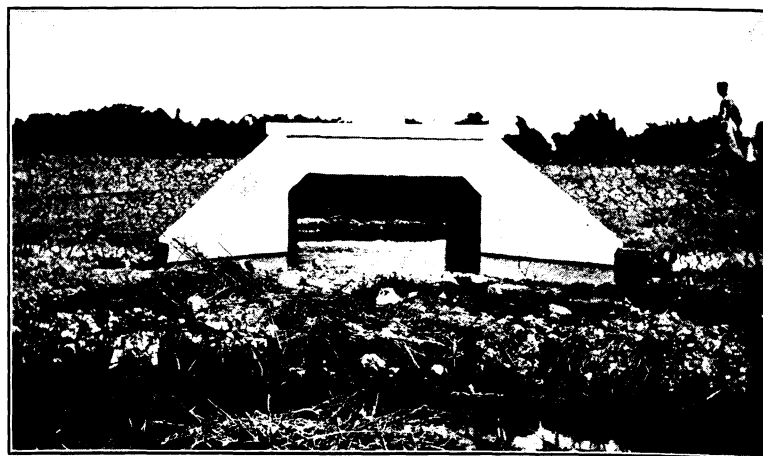
Session Road, the main street of Baguio, is being regraded and widened. A 4-meter sidewalk is being provided with concrete curb and gutter on the west side of the street in front of the business houses and an elevated sidewalk 3 meters wide on the east side. The roadbed will be 10 meters wide.

The work of completing Wright Park is now under way. Work on the development of this park was started about two years ago, and paid for largely from funds donated by friends of Ex-Governor-General Wright, for whom the park has been named. The appropriation is ₱2,500 and the work to be done consists principally in erecting two flights of steps 75 meters long and involves the placing of about 600 cubic meters of dry-rubble masonry.

The military hydro-electric plant on the Bued River, about 5 kilometers from Baguio, has been completed and is now supplying current for lighting Camp John Hay Reservation, Baguio. Arrangements are also being made with the military authorities for the plant to supply current to the city of Baguio for its use and for sale to private consumers. The present city plant will probably be used as an auxiliary to the hydro-electric plant in case of emergencies. The plant has 500 horsepower capacity which is probably large enough to meet all demands for current in Baguio for several years.

# BOHOL.

Work has been progressing rapidly on the construction of the Loay-Interior Road. Eight kilometers of the Loboc-Bilar section are almost complete. This project has been designated as an allotment project by the provincial board and with the allotment of ₱56,347 available, it is expected that the subgrade will be completed during the year or at least to within 3 kilometers of Bilar. The Loboc-Bilar section is 18 kilometers long. About 200 men are now working and it is expected that 200 more will be working early in April. This road will open up large areas of land in the interior of Bohol suitable for sugar culture, and it is believed will cause large numbers of the people from the seashore to migrate to the hill land.



A 3-meter culvert, Bureau of Public Works design.

A first-class road is being constructed near Maribojoc and Calape on the Tagbilaran-North Road and a second-class road near Inabanga. A second-class road is also being constructed near Candijay. The construction of the new location near Guindulman has been completed and opened to traffic.

The construction of three culverts near Dausi, and one bridge near Inabanga, have been advertised, but, no bids were received and they will be constructed by administration. It is expected that several culverts near Guindulman will be advertised for bids soon.

The standard tiendas in Tubigon are almost complete. No other market construction is being done at present except table construction at Maribojoc. Tables are to be constructed also at Loon, Loboc, and Tubigon in near future.

#### BULACAN.

The extension of the Manila-North Road to the Nueva Ecija boundary line, and the Bigaa-Quingua cut-off, has been completed. With the completion of these two units the road from the Rizal boundary to the Nueva Ecija boundary is rendered passable at all seasons of the year. Most of this road is a declared first-class one, but there still remain about 10 kilometers that it has not yet been possible to raise from second class to first class.

The provincial board has very wisely decided to spend all of the regular allotment, about ₱50,000, on improving the road between Calumpit and Pulilan. If weather conditions permit, it will be possible to finish enough of this road so that all forms of vehicles can reach the Pampanga boundary at all seasons of the year. The third member, Mr. Silvino Lopez, who is a resident of Calumpit, has volunteered to see that there is no trouble over right of way.

Money has recently been allotted for the construction of the Pulilan market. Plans for this building have not been definitely determined on, but about ₱12,000 should be available for the market building itself.

After considerable discussion in regard to the ownership of the school site at Santa Maria, the question of title has finally been adjusted and the construction of the building will be begun immediately. A 7-room structure is contemplated.

Through the efforts of the municipal president, Mr. Juan Racelis, approximately ₱10,000 allotted some time ago for the completion of the river wall in the barrio of Bustos, Baliuag, will be spent for the protection of the bank on the opposite side of the river. During the past year a slight change in the direction of flow of this river has caused a considerable erosion of the west bank, thus endangering the municipal market together with a considerable amount of private property. The president's efforts should result in an adequate protection of these structures.

A 2-room school building is to be built in the barrio of Bintog, Quingua. In order to secure this building the municipal president, Mr. Simeon Alba, not only had his town vote the necessary funds, but was instrumental in having the residents of this barrio build a gravel road connecting the school site with the main road.

The provincial water-supply system is being rebuilt. For some time the system as installed had been giving very poor service and recently the provincial treasurer secured authority to purchase a new engine which is being installed near the water tower. The new engine, together with a 7,000-gallon concrete tank into which the flow from an artesian well is diverted, should insure against any further difficulties due to a shortage of water.

Due to the efforts of the provincial treasurer, Mr. George P. Banner, and the municipal president, Mr. Damaso Caluag, the town of Malolos has recently voted ₱31,600 for the construction of a new market building. Of this amount ₱12,600 is provided from municipal funds. The balance is to be borrowed from the Insular Government. If the project is carried out under the present plans, a 30 by 43 meter building will be constructed. This will give Malolos the distinction of having the most commodious market building in the province.

#### CAGAYAN.

The construction of the Tuguegarao-Alcala first-class road is progressing very satisfactorily, 3 kilometers having been completed this quarter. The provincial board appropriated ₱45,000 this year for the continuation of this work and it is probable that the regular allotment of ₱28,062 will also be expended for this purpose. If conditions are favorable, the road will have been completed to within 10 kilometers of Alcala by January 1, 1916.

Of the ₱125,000 loan which was secured by this province for the construction of bridges, ₱50,000 has been released for the construction of the Bobogan Bridges, and requisitions have been forwarded for the substructure. The bridge designed for this location is a girder structure. The central span is supported on piers and all other spans supported on piles. Reinforced concrete is used for both the substructure and the superstructure.

Preparatory to Cagayan River control work the dredge and snag-boat *J. M. Dickinson* is being overhauled. The first project to be undertaken is the construction of hurdles about 10 kilometers above the port of Aparri designed to provide a greater depth of channel for steamships. For this work ₱15,000 was appropriated by the Philippine Legislature and a special allotment of ₱20,000 was made by the Honorable the Secretary of Commerce and Police.

The reinforced-concrete municipal building at Camalaniugan, which has been under construction for several months, is nearing completion. The estimated cost is ₱16,000; however, it is probable that it will be completed for somewhat less than this amount.

#### CAPIZ.

The Ibajay school building, standard plan No. 7, was completed by administration on February 16 and was occupied on March 2. Several minor items of finishing and painting remain to be done before turning the building over to the school authorities. This school has concrete partitions throughout. The total cost will come well within the estimate of ₱15,500.

Work has been resumed on the Tangalan-Ibajay Road with especial attention to completing the grading and improving the alignment over the mountain at kilometer 23 to kilometer 27. A considerable amount of through traffic is developing.

The new appropriations opened up the work on the Panitan-Pilar Road with renewed energy. The grading and bridge work are well advanced and the surfacing is rapidly approaching the last of the important sugar haciendas of the section.

Road work in this province has advanced somewhat faster during recent years than bridge work. The result is a large mileage of good roads, several sections of which are isolated, part or all of the time, by difficult rivers and dangerous wooden bridges. The policy adopted this year is to eliminate as many of the wooden bridges as possible and build several collapsible bridges which will bring the first-class road system up to its maximum efficiency.

The design for a 250,000-gallon circular concrete tank for storage of rain water for Capiz has been received. The estimated cost of the tank is ₱7,500. The question of drinking water for this municipality is a serious one. No artesian flow is obtainable, surface wells are brackish, and there are no fresh-water streams. The present supply of rain water stored in small galvanized-iron tanks or cisterns becomes exhausted after a few weeks of dry weather. The last of this water each season, sells for 1½ centavos per liter. After that is gone, very inferior well water is hauled 5 kilometers over the road and sold for ½ centavo per liter. The method of handling the water is extremely insanitary. The proposed tank would have a money value of not less than ₱10,000 per year to the community. The value in sanitation would be incalculable. The municipal treasury would realize a yearly profit of ₱2,000. It is to be hoped that a loan may be effected for the purpose of constructing the tank in time to take advantage of the next rainy season.

#### CAVITE.

Road construction work is distributed in small allotments this year so that practically every district in the province will have some construction.

The Carmona-Biñang, Malabon-Buena Vista, Naic-Maragondon, and the Tanza-Quintana Roads are to have about 2 kilometers each finished as second class, while the Zapote-Binakayan Ferry and the Naic-Indang Roads will have approximately 3 kilometers each completed first class.

The section between Zapote and Bacoar will be finished this season and this will complete a first-class road from Manila to Silang, just 50 kilometers long.

The Naic-Indang Road is 20 kilometers in length, with 11 finished first class, and with the work this season the completed length will be about 14 kilometers.

There are very many old Spanish adobe-stone culverts and American wooden culverts scattered all over the province. Two concrete-culvert gangs are working on replacing many of these and they will probably replace some 30 meters of span distance in old culverts with concrete.

School-building projects are very active this year. A No. 3 building has been completed in Dasmariñas and a No. 2 is being constructed in Bacao. One No. 7 concrete building will be erected on an excellent site in Silang. There are also two No. 7 buildings authorized, one at Indang and one at Alfonso. On account of the great distance, over 20 kilometers, to transport concrete materials, adobe stone, which can be quarried on the school sites, will be substituted for concrete. The walls will be 40 centimeters thick, all other dimensions will be the same as the standard-plan buildings. Adobe can be built in place at about ₱14 per cubic meter, while concrete at Alfonso would cost over ₱80 and at Indang probably ₱60 per cubic meter. Twelve thousand five hundred pesos is available for these two projects and it is estimated that they can be completed for this sum. Tanza will have a No. 7 building built this year, making a total of 33 schoolrooms to be completed during 1915.

Two adobe-stone arch bridges, one with 9-meter span in Indang, and one with 11-meter span in Alfonso, are to be constructed in connection with the work on the school building. These bridges will cost about ₱4,000 each.



## CEBU.

Construction work on the Cebu-North Road is being renewed and will be hurried to completion during this dry season. Culvert and subgrade work is now in progress.

Surfacing operations on the Cebu-Toledo Road are being carried on with a view toward making the road passable at all times. About 10 kilometers of the road were never surfaced and consequently during the rainy season travel over the road was difficult and for some vehicles often impossible. It is believed that with the completion of the surfacing there will be a very considerable increase in the volume of traffic.

The Barili-South and Argao-South Roads are under construction, sufficient funds being available to complete the former to Moalbual and the latter for a distance of 11 kilometers. The road to Moalbual may result in an extension of the Carcar-Dumanjug truck lines. The Argao-South Road will lessen the cost of transportation to the southern terminus of the Philippine Railway.

A water-supply system at the town of Sibonga has been provided for from Insular and municipal funds. The estimated cost is about ₱30,000. A new bridge will also be constructed in Sibonga along with the waterworks system. These two improvements are very necessary and will add a great deal to the sanitation and appearance of the town.

Second-class maintenance work is of considerable importance at present as an effort is being made to reinforce all temporary bridges so that they will not be rendered impassable during the coming rainy season. It was thought that repairing these bridges now would result more economically than if it were held off until late in the year when all maintenance work is demanding unusual attention.

The disinfecting building at the Cebu quarantine station has been completed by administration with unusually good results from the standpoint of economy. The plans called for a building containing office and storerooms along with sufficient space for the disinfectant machinery that is commonly used in quarantine stations. The walls, partitions, and floor were to be of concrete with heavy galvanized-iron doors, iron grilles at the windows, and a tile roof. The area of the building is 257.6 square meters and 164 cubic meters of concrete was used in its construction. The lowest bid received for the completed building was ₱12,400 so work was commenced by administration. The cost, on the basis of the contractor's bid has been ₱9,314.02 with an additional ₱1,064.02 for surcharges, making the total cost ₱10,378.04. The cost was divided as follows:

Labor .....	₱3,017.84
Materials .....	6,230.99
Transportation .....	65.19
Surcharges .....	1,064.02
Total .....	10,378.04

It is interesting to note that the tile roof cost only ₱1,375 in place, not including trusses or purlins, while it is estimated that an iron roof, using 22-gauge American ingot iron, would have cost ₱1,050.

## COTABATO.

The Province of Cotabato has made the following appropriations for public works during the year 1915:

Construction Cotabato-Tamontaca Road.....	₱7,000.00
Construction Cotabato-Parang Road.....	5,000.00
Construction Parang waterworks.....	10,000.00
Construction artesian wells.....	2,000.00
Irrigation, head control, and laterals.....	600.00
Construction Glan Dock.....	2,500.00
Construction Cotabato Wharf.....	2,000.00
Construction telephones and telegraph lines.....	3,700.00
Maintenance Cotabato-Tamontaca Road.....	5,000.00
Maintenance Cotabato-Parang Road.....	2,000.00

A brief description of the work to be accomplished on the above-mentioned projects is as follows:

On the Cotabato-Tamontaca Road there are 5 kilometers of old trail inherited from the military that require surfacing. Heretofore the metalled section has been chiefly coral sand placed over a thin crust of gravel watered thoroughly, and rolled with a 500-pound roller. The watering process has developed a crust that is hard on top as long as the road has plenty of water. What will happen in the dry season if any loaded carts pass over same remains to be seen. One of the old discarded 3-ton road rollers has been made available for use by a little remodeling, and can now be operated fairly well by two bulls or about 15 laborers. It is made to run in either direction without turning the roller. The bulls are either unyoked and hitched to the opposite tongue or the men reverse their position. The present plan is to place the gravel in two courses of 8 centimeters each, using only enough sand on the first course to bind the gravel together. A 3-ton roller over a gravel surface still leaves much to be desired, but it is a question at present of limited funds. The only bridge in the province was formerly located at station kilometer 4.6 on this road. It was a timber structure throughout, supported by 11 bents of piling,

4 piles to the bent. In the forepart of the month of February 4 of the bents collapsed, carrying with them the superstructure. Investigation at the mud line of all the piles revealed that in that locality many of the piles were so alive with teredos that a sharp blow with a sledge hammer would have been sufficient to have completely severed the pile, and all the piles were infected to greater or less extent.

The survey for a new site has now been completed and it is hoped that a special appropriation may be available for replacing the old structure with an up-to-date concrete-pile bridge.

The Cotabato-Parang Road work consists in the construction of about 3 more kilometers of new trail in the vicinity of the Simauy River to connect with the old military trail just north of the Simauy River in the hill section. Some of the existing kinks and heavy grades will have to be eliminated.

The Parang water works appropriation is to cover the cost of installing two 6-inch Rife rams for the town of Parang on the Parang River. These rams will elevate the water to the top of the hill just back of the town where it is proposed to construct a small wooden tank at the point of delivery to supply the town of Parang through a 3-inch main already in place.

Glan Dock was but recently completed. It is located near the site of one of the new agricultural colonies and is intended to facilitate trade with the colonists at this station. The dock is of native lumber, supported by 32 pile bents, measuring over all 610 by 8 feet, except at the landing stage, which measures 17 by 9 feet.

The proposed Cotabato Wharf is to replace a small timber structure that has been almost entirely destroyed by teredos. It will measure 52 by 26 feet, and will be supported on concrete piles with concrete caps.

The Province of Cotabato covers such an area that the question of travel and communication is no easy matter. There is already telephonic communication with the colonies located between Reina Regente and Picket, but only the monthly boat to connect with points along the southern coast as with the colony at Glan. The telephone work to be done this year consists of the construction of 175 kilometers of line that will connect Reina Regente with Glan and a few intermediate points.

Although there has been no appropriation for irrigation work of any importance, data is being collected as to the possibilities of obtaining water for the various colonies that have already been established and in order to assist in the location of new colonies in the future. The most of the colonies that have been already established have been given their present location on account of the natural fertility of the soil in their respective localities.

## ILOCOS NORTE.

The Batac market, standard type B, a 21 by 43.5 meter building, which was completed last December, will soon contain standard sales tables of scheme No. 1 the contract for which was given to Mr. Daniel Galza for ₱2,350.

The construction of the Laoag market, a 30 by 43.5 meter building, and a double tienda of 4 by 6 meters, is nearly completed; while the construction of the other tienda cannot proceed, due to a delay in the receipt of materials.

The Laoag East Central School building is practically finished with the exception of about 30 per cent of the roof which awaits the arrival of roofing iron.

The construction of the Pasuquin standard school building, plan No. 7, has progressed very rapidly leaving uncompleted the partitions and ceiling. An appropriation of ₱10,707 was made for the building, the lumber for the floor, ceiling, partitions, and trusses being donated.

The reconstruction of the Bacarra collapsible bridge was completed, using local lumber.

A diversion near the steepest grade on top of the Baruyan Hill is now under construction, which will assist the passage of loaded carts. Steep grades near and by Cape Bojeador are also to be eliminated for easier ones.

To insure complete communication all the year between the towns in the province, the construction of a first-class road from San Nicolas to Dingras was recommended. This will eliminate the necessity of building a bridge between San Miguel and Dingras on the Laoag River. During the rainy season the towns of Dingras, Solsona, and Banna experience much difficulty and hardship in crossing the river at Milamilan. As the owners of land in the above eastern towns are mostly from Laoag and also the rice mill is in Laoag, carts will have to use the proposed road and pass the Laoag Bridge to go to Laoag. The construction of this road will also aid the transportation of products from the fertile fields between San Nicolas, Batac, and Dingras.

## ILOCOS SUR.

The work on the Santa Cruz Diversion Road, which forms a part of the Manila-North Road has progressed beyond expectations. The remaining 3.48 kilometers of subgrade has been finished, which makes a total of 13.48 kilometers. The cost was published in the January, 1915, Bulletin. Four kilometers of the road have been surfaced with gravel and rolled. The cost of the gravel per cubic meter for the entire road averaged ₱2.

Kilometers 61, 62, 63, and a part of 64 of the road between the municipalities of Candon and Santa Lucia, and which form a part of the Manila-North Road, are nearing completion, at a cost of about ₱4,000 per kilometer.

Kilometers Nos. 3, 4, and 5 of the Vigan-North Road are under construction, kilometer 5 being entirely completed and the subgrade on kilometer 4 and a portion of same on kilometer 3 have been finished. The cost, per cubic meter of earth, including cuts and fills, averaged about 18 centavos; the average cost of rolling kilometer 5, including subgrade and surfacing, ₱800; the cost of gravel per cubic meter was ₱2.25. The total cost of kilometer 5, including surcharges, was ₱4,500. The 2 remaining kilometers will cost less than the above-mentioned one as the haul of surfacing material will be less.

The land where the markets are to be constructed in the municipalities of Cabugao and Santo Domingo has been cleared of all the houses and the construction work on the buildings has been commenced.

The original plan for the Candon Bridge was a one 49.34-meter (161 feet 10½ inches) steel, and four 9-meter I-beam spans, with a roadway width of 4.27 meters. The work was let under contract for the construction of the substructure and the erection of the superstructure, the province furnishing the material for the superstructure except the floor which was of concrete and which was included in the contract for the construction of the substructure. The contracted price for the work above specified was ₱24,800. Work was commenced by the contractor on April 1, 1913, the contract being taken away from him on May 31, 1914, for inability to construct same, after being given three extensions of time by the honorable provincial board of this province. At the time the contract was suspended he had finished 50 per cent of the work. Work was commenced on June 1, 1914, by administration under the supervision of the district engineer and was finished on December 31, 1914. After the heavy storm of July 28-30, 1913, it was found that the waterway had to be increased, therefore the bridge was lengthened by constructing two 9-meter spans, also the elevation was raised 1 meter, and 51 duñon piles were placed under the two center piers. The total amount paid to the contractor up to the time that the contract was suspended was ₱18,153.99, which included all work that he had done in accordance with the contract, also the extra work accomplished in accordance with the revised plans. The total cost of the bridge, including surcharges, was ₱66,142.93. The total amount appropriated in accordance with the estimate was ₱76,769.04. A saving of ₱10,626.11 was made to the provincial government by having the work taken over and done by administration under the supervision of the district engineer. The bridge was dedicated on January 11, 1915, about 6,000 persons being present.

The following appertains to the progress of the Singson water-works:

The excavation at the tank site on Mira Hill was commenced December 15, 1914. The hill was cut about 3 meters in elevation, thus giving a firm foundation. On March 6, 1915, the tank walls were completed to elevation 3.70, which includes the cornice on the pedestal. To date (March 8, 1915) all the cast-iron pipes for the distribution system, furnished by Frank L. Strong & Co., and the steel pipes for the supply main, supplied by Germann & Co., have been received. They are now being transported. It is expected that the tank, head-works, and supply main will be finished and ready for operation by July 4.

## ILOILO.

A reconnoissance has been made of a proposed road from Guimbal north to Tubungan, a connection from the latter-named place to Leon to follow when funds are available. The province has also provided ₱3,000 for the reconstruction of the trail from Guimbal to Igaras.

The steam dredger arrived in Iloilo, February 19. The dredging of the lower reach of the river was immediately started. With the funds appropriated, about four months' services are available, during which time it is planned to prepare both the lower and middle sections of the river for the approaching sugar season.

The Panay auto line continues in operation between Pototan and Janiway and Pototan and Barotac Nuevo. The receipts in January of the current year were increased about 33½ per cent over any previous year and the prospects for a successful season are excellent.

Work on the river wall will be resumed at an early date. An appropriation of ₱75,000 has been made for the continuation of the work from Calle Arsenal to Calle Aldeguer and as soon as the same can be properly advertised and the contract awarded, if a desirable offer is made, work will be started.

The construction of the last 3 kilometers of the Pototan-Dumangas Road is well under way. This is the last link in the road from Iloilo to Dumangas, via Santa Barbara, Cabatuan, Janiway, Pototan, and Barotac Nuevo. When completed, it will give the province a continuous stretch of 65 kilometers of first-class road. Work will then be started on the reconstruction of the Pototan-Dingle Road, which, when finished, will give the province a continuous first-class road from Iloilo to Tabugan via Pototan and Dingle of 61 kilometers.

The market building at Barotac Nuevo, a type A standard 18 by 46 meter building, was completed and accepted on December 24, 1914. The work is excellent and was completed within seventy days.

The work on the Lucena-Jalaur Road has been stopped temporarily until more funds are made available.

The work on the San Miguel-Leon Road is being pushed ahead with great rapidity to take advantage of the dry weather. Over 300 men are employed. Grading has reached kilometer 6, while surfacing is following behind at kilometer 5.

Twenty thousand pesos were appropriated for the reconstruction of the Tigbauan-Guimbal Road, and as soon as the San Miguel-Leon Road is finished the force will be transferred to Tigbauan.

Bids were received for furnishing gravel for the maintenance of first-class roads. Bids for 19,700 cubic meters of gravel were accepted, while the rest, for 2,250 cubic meters, were rejected, it being found cheaper to obtain the gravel by administration.

Construction work on the Iloilo central school building is being pushed rapidly and will be completed early this month. The actual elapsed time of construction will be considerably less than five months, and the cost will be well within the appropriation and will show a substantial saving over the bids submitted. A comprehensive drainage system has been installed to care for the storm drainage and the interior patio has been parked to drain to it. The outside lawn will also be graded to the best advantage for drainage. Altogether, the building and grounds will present a very handsome appearance.

Work on the Dumangas presidencia is progressing slowly, but the contractor is doing exceptionally fine work. The woodwork, especially, is worthy of mention, as all of the timber used is clear select and the narra and ipil used are exceptionally beautiful. The contractor has asked for permission to substitute for partitions banuyo instead of lumbayao without any increase in cost. As the banuyo used is hardly distinguishable from narra, this will make an exceptionally handsome interior finish.

Reconstruction work on the Janiway School is well under way and consists of putting a new roof, new floors, and new windows in an old adobe stone building which is a relic of Spanish times. When completed, it will be a fairly satisfactory school building. The cost of the repairs, or reconstruction, will be about ₱5,000.

Investigation work has been regularly carried on in relation to the Iloilo water supply. Weirs have been installed in several places in Guimaras and daily readings taken of the amount of water available. While there is not sufficient daily flow to guarantee a supply for the city, it will be possible with comparatively little expense to construct a dam and head works to impound a six months' supply which will be ample. The reservoir site is situated 7½ kilometers from Iloilo, on Guimaras Island, and has an elevation of approximately 100 meters, assuring ample pressure and allowing the use of a minimum-size pipe. There will be, of the pipe line, a little over 6 kilometers on land and about 1½ kilometers submerged across Guimaras Strait from the Island of Guimaras to Iloilo.

The Molo market, O'Leary & Burns, contractors, a 24 by 42.8 meter, type B structure, has been completed by the contractors and turned over to the city. The job was completed in eighty-six working days and is an exceptionally fine piece of work, both from an architectural and a construction standpoint. It is located on a prominent corner and the carved-ipil corbels and red-tile louvers are very handsome.

Five hundred lineal meters of Guimaras limestone surfacing, 15 centimeters in thickness, have been put on Calle Ledesma and the road is giving excellent satisfaction. The intention is to resurface all the roads in the vicinity of Iloilo with this limestone and later using the limestone as a telford base to surface with a thin layer of the Nabalas basalt which has proved so satisfactory elsewhere in Iloilo.

Calle Progreso is now being surfaced with limestone rock in the same manner as Calle Ledesma. We hope, also, to give it a coating of the black basalt at some future date.

Work on the Molo Jetty is slowly progressing. The contractor is hampered by an inadequate plant and inability to always secure transportation when needed. However, the piers are beginning to take form and a very noticeable bar is already being formed as anticipated. Sufficient improvement is already noted to predict the success of the plan in reclaiming a large foreshore area.

#### ISABELA.

Grading on the Cordon-San Luis Road is now completed. The work on surfacing on the whole section is progressing very well, and it is expected that at the end of June the whole 9.7 kilometers will be designated first-class road.

The work on the Ilagan-North Road is going on without delay. Two kilometers north of San Pablo is already completed, making a total of 3 kilometers of first-class road. On the Ilagan-Tumauini section, 2 kilometers are graded and  $\frac{1}{2}$  kilometer surfaced. The gravel here costs from ₱2 to ₱2.50 a cubic meter, having a haul of from 2 to 6 kilometers. The road from Angadanan toward Cauayan will soon be under construction. With the money available, 6 kilometers at least will be built this year. The work on grading has been awarded to subcontractors at 50 centavos per cubic meter.

The various municipalities are interested in public works. The Municipality of Cauayan appropriated sufficient money to build a first-class road from the town to the river landing, a distance of 1.8 kilometers. The work is being supervised by the district engineer.

Cauayan, Echague, Angadanan, and Cabagan appropriated money for Gabaldon school buildings, and are only waiting for Insular aid. Ilagan and Echague have now funds to build modern markets and are waiting the inspection of sites and the approval of loan by the Executive Bureau. With voluntary contributions from the people of Angadanan, a concrete box culvert is to be built at Bua Creek.

One of the main streets of the town of Naguilian will be reconstructed to a first-class standard by the people living on it under the supervision of the district engineer. This is a part of the present provincial road.

The Constabulary barracks was inaugurated with a big "baile" on March 6 and 7 and was occupied March 8. The total cost of the new cuartel is ₱23,297.26, including surcharges and free soldiers' labor. The following is the itemized cost:

Material .....	₱13,883.64
Transportation from Manila to Ilagan .....	3,325.81
Labor .....	2,466.57
Supervision .....	739.09
Surcharges .....	2,041.01
Total .....	22,456.12
Soldiers' free labor .....	841.14
Total cost .....	23,297.26
Appropriation .....	22,791.91
Balance .....	335.79

Other work expected to be done soon is removing stumps from the Cayagan River. An experiment made with block and tackle, rope, and carabaos, cost ₱5 per stump removed.

In spite of the low water in the Cagayan River, small boats with detachable Evinrude motors are plying between Aparri and Cauayan. These boats can carry 10 people and can run up the river from 6 to 10 miles per hour. The motor is ordinarily  $3\frac{1}{2}$  horsepower.

#### LAGUNA.

An additional allotment of ₱25,000 having been secured, work on the San Pablo-Nagcarlan Road has been continued, and now something over 8 kilometers have been completed, while 2 kilometers more of subgrade are nearly ready for surfacing. These 2 kilometers include  $1\frac{1}{2}$  kilometers of new road through a coconut grove where rather heavy work was encountered. The abandonment of the old road was due to the heavy grades running as high as 17 per cent found on it, while the new road climbs the hill 57 meters high with a 5 per cent grade.

In addition to the construction of a private road 300 meters long for Mr. Eusebio Quintana, we have, using stone from the Los Baños Quarry, surfaced streets in the following towns, with expenditures as indicated:

San Pablo .....	₱2,100.00
Los Baños .....	1,500.00
Santa Cruz .....	1,200.00
Magdalena .....	500.00

This is the third consecutive year we have done street work for San Pablo, and it is largely due to their appreciation of the work that the other towns decided to have their street work done by this office.

An allotment of ₱80,000 having been received, work on the Calamba-Vigaa Road has been started at the Batangas line and will be pushed to completion during this season if nothing unforeseen prevents. This road will connect the first-class road system of Batangas with the Manila-South Road, and its improvement will be of great benefit to the Batangas people, and, incidentally, to the Calamba market.

The steel bridge at Pagsanjan is nearing completion, all the concrete and about half of the steel being in place. The contractor, Mr. John Gordon, will finish the job within the contract time.

Both abutment foundations of the new San Cristobal Bridge are in place and the placing of the centering for the arch is ready to begin. Some difficulty was encountered in finding good foundations and it was necessary to go 30 centimeters deeper on the Calamba side, and 1.2 meters on the Manila side before satisfactory soil was reached. Now that the foundations are in, the remainder of the work will be pushed to completion as rapidly as possible.

The copper tiling for the tower of the Rizal Memorial School at Calamba has been received, and this building will soon be completed and turned over to the Bureau of Education.

The painting of the Laguna High School is just about finished and this will complete the building, which has been occupied for some time by the Bureau of Education, the painting not being done previously on account of lack of funds.

The repairs on the Biñan schoolhouse have been completed, save the painting which is under way and will be completed shortly. The No. 3 building at San Pedro is 75 per cent completed, and, save the tower, will be finished in April. The No. 2 building at Santisimo Rosario, San Pablo, is completed, save the painting which is under way.

New schoolhouse construction is contemplated in the following towns: Alaminos, No. 3; Bay, modified No. 3; Santo Niño, San Pablo, No. 2; Nagcarlan, domestic science; San Pablo, an addition to No. 10 constructed in 1911.

New market construction is contemplated at Lilio, San Pedro, and Los Baños, and surveys of market sites in these towns have been authorized and made.

The new laboratory at the College of Agriculture, Los Baños, has been completed and turned over to the college for occupancy. The Bureau of Forestry have an appropriation of ₱10,000 for a building at the college, and expect to have part of a Bureau of Education plan No. 7 erected in time for occupancy before the opening of the college in June.

The intake or gate house of the San Pablo waterworks has been completed, and two-thirds of the pipe received, the remainder having been jettisoned during a storm at sea. The laying of the pipe will begin on Monday, April 5, and it is expected that the part lost will be replaced and received by the time the pipe on hand is all laid, so that the work may be continued without interruption.

The output of the Los Baños Quarry for the quarter ending December 31, 1914, was 3,013 cubic meters, and it is estimated that it will be 3,600 cubic meters for the present quarter. Very little was done during January and February, but business picked up during the latter part of March, and with the orders on hand it is probable next month's output will be the largest to date. Extensive improvements are under way and will be completed during the next quarter which will permit of the production of better graded stone at a possible reduction in price.

During the months of January, February, and March, 1915, the extraordinary traffic on the roads in the vicinity of Calamba have destroyed the metalling on kilometers 52 to 55, inclusive, of the Manila-South Road and have badly damaged kilometers 43 to 51, inclusive, of the same road, as well as kilometers 55 and 56 of the Canlubang road and 44 and 45 of the Santo Domingo road.

This traffic consists of traction engines and trucks, both with trailers, transporting sugar cane.

The experience gained from observing the damage done is convincing that laws regulating such traffic are imperative, and should govern both the speed of the vehicles and the loading in connection with the kind and width of tires and wheel diameter.

#### LANAO.

The office of the district engineer was established on March 8, 1915.

Bids for furnishing and delivering about 50,000 feet b. m. of several kinds of lumber for the addition to the Lanao Civil Hospital, at Dansalan, were opened on February 15, 1915. The successful

bidder is the Port Banga Lumber Company of Zamboanga, with a bid of ₱4,800 for the lumber delivered at the mills. The cost of transporting this material to the site will be about ₱2,200—about ₱700 for water transportation and about ₱1,500 for land transportation—and, if it were not for the fact that the secretary-treasurer for the province had secured from the O. K. & L. Automobile Transportation Company a rate of ₱30 per 1,000 feet from Iligan, port of disembarkation, to Dansalan, the sum would amount to ₱3,200. That is, the flat rate of 2½ centavos per kilo is charged on this material as on any other articles carried by the transportation company from Iligan to Dansalan, a distance of about 36 kilometers and a difference of elevation of about 700 meters (3,200 feet). Most of the other materials, except the cement, are on the building site.

A grounded-circuit telephone line is being constructed from Dansalan to Tamparan, a distance of approximately 28 kilometers. This line will pass through a certain section of the province—the Romain and the Taraca Valleys—which have been the object of so many military expeditions, and will connect the isolated Scout post of that place.

Preparation is being made to start the reconstruction of the Iligan Suspension Bridge approaches at once.

#### LA UNION.

The people of the province of La Union are greatly pleased this year over the receipt of ₱25,000 from the Insular Government in the form of a special allotment, and ₱25,965 more in the form of a regular allotment. Forty thousand pesos of the above mentioned have been appropriated for the construction of the Balaoan-Bangar section, Bacnotan-North Boundary Road, on the Manila-North trunk line, and work was started at once, March 1, 1915. Beach and river gravel is being used for metalling material. This section is 9 kilometers in length and will have two concrete overflows of 240 and 300 meters long, respectively, about 1 kilometer apart. It is estimated that all the work left out last year can be finished with the amount appropriated, and the whole section completed before the rainy weather sets in, excepting the overflow sections, which are left to be done after the rainy season is over.

The remaining ₱10,965 of the above regular allotment will be expended on the construction of the Caba-Aringay Road, 4½ kilometers long, also on the Manila-North Road. The survey of this road has been completed and the plans and estimates are well under way.

The Caba section (600 linear meters in length) of the Bauang-South Road was completed February 28, 1915. This gives La Union Province a total kilometerage of 59.5 of first-class roads.

The standard 18 by 38 meter market building at Naguilian, mentioned in the January 1, 1915, issue of the Bulletin, has been completed by administration at a total cost of ₱15,960.06, including surcharges, and accepted by the municipal board March 1, 1915.

The street construction for the San Fernando standard market layout was begun March 16, 1915. The new street will be 12 meters wide between gutters and 7 meters between shoulders, in accordance with the plans.

The construction of the Luna presidencia, mentioned in the July 1, 1914, issue of the Bulletin, is now 80 per cent completed, but the work will have to be discontinued through lack of funds. There is only ₱1,000 left to buy the windows and doors, and an additional appropriation of ₱2,000 will be necessary to completely finish the building.

The construction of the cable tramway across the Naguilian River, which was started in the middle of April, 1914, by Mr. Frank Smith, jr., of San Fernando, La Union, the contractor for the work, has progressed rather slowly. The work consists in erecting a wooden tower on each bank of the river, and another wooden tower on a concrete pier 260 meters from the west bank to support the cable. The estimated cost of the whole structure, complete, was roughly ₱15,000. The erection of the towers and the concrete pier was awarded by contract to the said Mr. Smith. Both towers on the banks have been completed, but the contractor is having great difficulty in the excavation for the pier, which is designed 3.86 by 10.06 meters in area, and to rest on wooden piles, the top of which is to be 7.20 meters below the present surface of the ground. There will be a 3-meter head of water by the time the excavation reaches the required grade, and the water has been coming in through the porous, gravelly subsoil faster than it could be pumped out with the type of pump the contractor formerly had on the work. The excavation on the date of this writing was down to grade at the center, and about 0.50 meter higher at the sides, and as soon as the new pumping plant and the pile-driving outfit ordered by the contractor is received, the driving of the piles will be started (in about a week), and it is expected that the work will be carried through to completion without any difficulty.

#### LEYTE.

During the quarter the Palo school building (standard No. 7 with concrete front) was completed by administration.

Its cost, exclusive of surcharges, was as follows:

Miscellaneous .....	₱286.42
Labor .....	3,416.61
Material .....	8,516.89
Outstanding obligation .....	1,731.00
Total .....	13,950.92
Estimate, omitting surcharge .....	14,100.00
Lowest bid, omitting surcharge and inspection .....	14,650.00

It will be seen that a saving of over ₱700 was made by accomplishing this project by administration. American ingot iron was used for the roofing.

The Tacloban market was started by contract on January 6, 1915, but to date only 10 per cent is completed.

The Capocan school building (standard No. 2) was completed by administration in twenty-eight working days at a cost of approximately ₱4,400, excluding surcharges. This is an extremely isolated project and the results obtained as to time, cost, and appearance of the school are extremely gratifying.

One abutment of the Guinarona Bridge, a 12-meter standard, reinforced-concrete, deck girder bridge on timber piles, at kilometer 37.6 Palo-South Road, has been excavated to grade and driving piles has commenced. As the large pile driver and hoisting engine are employed on the west coast bridges, driving is being done by hand, using a 17-foot pile driver and a 1,000-pound hammer.

The concrete piles at Gang-ilang and Labo-on Bridges (Matalon-Inopacan Road) are not showing sufficient bearing which has necessitated their being lengthened and, in two instances, the driving of extras in order to obtain the required bearing. Notwithstanding these handicaps, both bridges will probably be finished within the respective estimates.

No bids having been received for the construction of the Consolacion barrio school building (standard No. 3), the work has been started by administration.

The municipality of Baybay has appropriated ₱4,000 with which, with the ₱2,000 saved in the construction of the market, it is intended to construct a block of ten 4 by 4 meter tiendas. Material has been received and work will shortly commence.

Work will also shortly commence on the Barugo and Naval school buildings (both standard No. 7).

The unprecedented development in truck and trailer traffic has greatly increased maintenance costs in this province. Another factor which tends to hinder the maintenance work is the unsatisfactory character of all surfacing material in Leyte. Tests at the Bureau of Science show an abrasion of from 4 to 10 per cent and a toughness of about 2. Some of the stone is too soft to cut cores from for tests. Generally speaking, the cementation value is satisfactory, therefore, while the Leyte roads are extremely satisfactory for ordinary or light traffic, they cannot be expected to stand up under the class of very heavy, iron-tired traffic that now exists and which will probably continue to increase without high maintenance charges.

About 5 kilometers of the Dulag-Abuyog section of the Palo-South Road has been graded since January 1 and metaling has been laid for about 1 kilometer. In order to meet the demands of the heavy traffic the metaling on this section will be laid 15 centimeters thick for the first course and 10 centimeters thick for the second course. A larger size of stone is also being used in the bottom course. The stone is obtained from the Calbasag Quarry and is hauled to the road on a tramway by a locomotive. Its cost on the road will probably vary from ₱1.90 to ₱2.20 per cubic meter. The grading is now "paquiaod" at 35 cents per cubic meter, but the supervision and subsequent filling up of settlements brings the cost up to about 40 cents per cubic meter.

This province received a regular allotment of ₱81,484 which the board voted to spend on project 15 (construction of Palo-South Road and bridges).

Advertisements have been made for the construction of the substructure, and the erection of the steel of the Mainit Bridge at kilometer 31.4, Tacloban-Carigara Road. This is a steel truss of two 120-spans on a concrete substructure.

#### MANILA.

The reconstruction of the cold storage sections of the Insular ice plant has been completed. These sections were formerly of Oregon pine, insulated with mineral wool. The construction is of reinforced concrete throughout, insulated with cork. The work has taken several

years to complete, due to the fact that it had to be carried on without interfering with the normal operation of the plant.

Three new lighthouses have been completed in the Sulu Sea, namely, the Black Rock Island, the Manucan Island, and the Comiran Island lights. A light is now under construction at Baliscan Island on the east coast of Luzon, and extensive repairs are under way at the San Bernardino and Capul light stations in and near the San Bernardino Straits.

Dredging operations are now under way at Iloilo, Aparri (Cagayan River), and Manila. Dredging at Cebu will start shortly after April 1. At Iloilo the Bureau of Public Works seagoing suction dredger is working, the work at Aparri is being done with the *J. M. Dickinson*, and dredge No. 1 a bucket dredge equipped for deep-water dredging is to be sent to Cebu. In Manila, dredge No. 2, similar to No. 1, is at work in the Pasig River, Priestman dredge No. 5 is working in the Estero Reina, while dredges Nos. 6 and 7 will be put to work in various sections of the Pasig River as soon as repairs are completed.

A new fireproof vault has just been completed for the Philippine Library.

Extensive alterations are under way in the Bureau of Agriculture Building and in the old Museum Building, which is to be occupied by the Bureau of Forestry.

### MINDORO.

During the past year three very nice flowing wells have been secured in the town of Naujan. These wells are of great value to the people living in this town for they are the only source from which a supply of thoroughly desirable water can be secured.



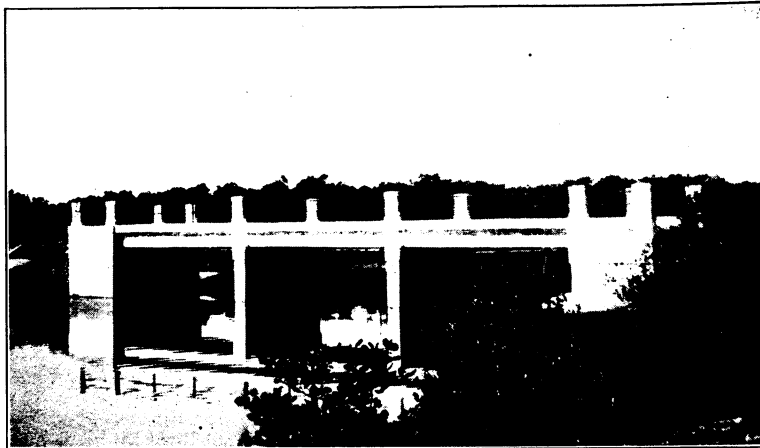
Concrete-pile wharf, Calapan, Mindoro.

Active work is in progress on the Calapan-Jose Road. This road is to a large extent a development project, for it traverses a good many kilometers of entirely undeveloped but very fertile valley land. However, its main object is to connect Calapan with the coast-line towns to the south and should eventually become the main coast road of the province.

The present conduct of this project is of interest, for all grading work is being done by slips drawn by carabaos. From 15 to 20 animals are being used and the rapidity with which the grading work is being handled is an ample demonstration of the efficiency of this method of construction.

Due to the energy of the treasurer, Mr. Thomas I. Weeks, the town of Calapan is likely to secure a new water-supply system. Some 2 kilometers from the town there are a number of very excellent springs and while the elevation of these springs is not great, it is sufficient to deliver the water to the town under a small head. As the town of Calapan is greatly in need of a water supply but is not at present rich enough to install a large pumping plant, it is planned to utilize the water from these springs merely for drinking purposes and to leave the matter of fire protection until a later date.

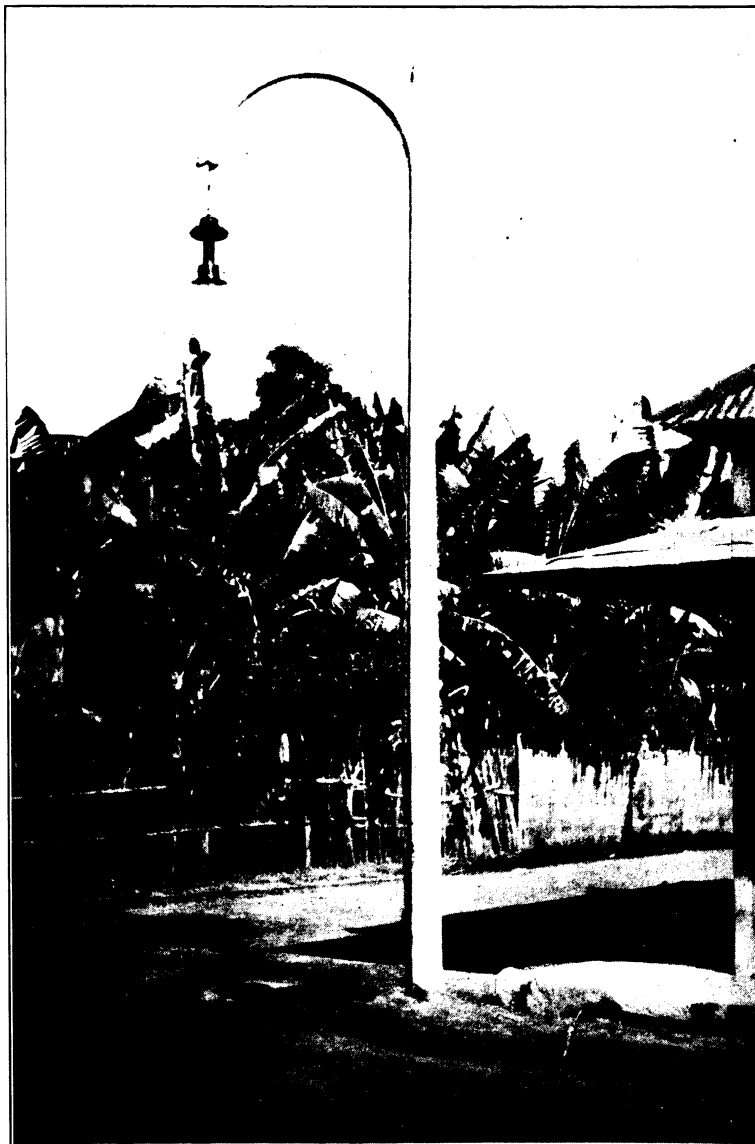
The Calapan-Naujan Road is nearing completion. This road is a beach road connecting Calapan and Naujan and is of particular interest because of the fact that it is almost entirely a sand-clay road. Sand-clay roads have not usually been successful in the Philippine Islands. However, the road between Calapan and Naujan seems to meet all of the present traffic requirements as well as they could be met by a more expensive road. The unusual success of this road is to be accounted for not only by the fact that the natural combination of sand and clay is an unusually good one, but also from the fact



A 3-span concrete-pile bridge, Calapan, Mindoro.

that the rainfall in this part of Mindoro is so uniformly distributed that this road never becomes excessively dry.

The town of Calapan has installed a number of concrete lamp posts of unusual but very attractive design. These lamp posts are apparently giving satisfaction and are undoubtedly of much better appearance than the ordinary wooden poles. Engineers who are interested in municipal lighting systems might find this design of interest.



A concrete lamp post, Calapan, Mindoro.



## MISAMIS.

Surveys are being made for a road between Mahinog and Guinsiliban and also between Agohe and Catarman on the Island of Camiguin. Each section is approximately 10 kilometers in length. With the construction of these sections it will be possible to make an automobile trip entirely around the island, about 65 kilometers. The route will be of interest not only to local residents, but to tourists as well.

For 7 kilometers east from Mambajao the road passes through beautiful coconut groves and frequent barrios to Cabiling Point, a rocky promontory over which the road is carried on easy grades and through picturesque scenery. From here to Mahinog, 7 kilometers, are encountered the lowlands again.

From Mahinog the road follows the beach for about 4 kilometers, crossing the shallow Binuni Bay on a rock fill, and then bears inland, taking the traveller through a natural kaleidoscope of forest and jungle, hemp fields and coconut groves, winding in and out among the hills to Guinsiliban, a barrio at the head of the little bay of the same name. From here through Sagay to Catarman the road follows the beach for the most part, except it is shorter to go up over the promontories than to go around them.

At this point the road has the unique distinction of being located over lava beds, as yet decidedly unstable from their proximity to Camiguin Volcano. Sulphurous smoke is constantly issuing from the shallow crater, the refreshingly cool springs emit gases that make it difficult to drink directly from the spring, and at Bonbon many hot springs come out under the sea, thus putting a hot salt bath entirely at the traveller's service. The bare 700-foot cone stands in striking contrast to the higher, thickly wooded mountains that surround it. In one of these is an active volcanic fissure, a sulphurous streak plainly visible from the road.

The people of Camiguin are of a vigorous and progressive race, fully disposed to take advantage of the natural resources of the island. Mambajao has just appropriated ₱5,000 for port improvements, and has requested an Insular loan for the same purpose. The complete improvement is estimated to cost about ₱30,000. The town is an important shipping center for hemp and copra, and for its resources can boast probably of as many improvements as any town or city in the Philippines. These include a waterworks system serving all the barrios of the municipality; public hydrants and fountains; fire plugs; four reinforced-concrete school buildings, two of which have 10 rooms each; an excellent municipal building; paved streets; and an electric light project already under way.

Tramway has recently been purchased for operation on the west coast and by its use it is expected to develop the road work between Misamis and Oroquieta, where the absence of carabaos, bull carts, and roads has retarded the growth of a section of great natural agricultural wealth.

Balingasag on the east coast has recently appropriated funds for a waterworks system, and Cagayan, the capital, has requested loans for the same purpose. In Cagayan plans are being developed for a carnival in August that promises to rival her more prosperous neighbors, Cebu and Iloilo.

Excellent progress has been made on the Cagayan-West Road and traffic now finds no impediment as far as El Salvador. The objective is the provincial boundary near Iligan in Lanao Province.

A serviceable ferry has been installed at Cagayan and its usefulness has been fully determined by the demand for its continuous operation.

The Cagayan-Talacagcar Road is making good progress, so that the Bukidnons will soon be able to bring their produce over a good road while in Misamis Province.

Funds have been requested for the improvement of the ports of Cagayan and Misamis, both being natural harbors where the expenditure of small sums would develop excellent harbor facilities for loading and unloading vessels.

Smith, Bell & Co. have recently enlarged their bodega facilities, and Porfirio Chaves & Co. have also started bodega extension work. This augurs well for the increasing commercial importance of the port of Cagayan.

Misamis municipality has a large and thriving lumber mill and just opposite are the large Kolambungan Mills. With better port facilities for handling cargo, this port should be one of the most popular on account of its natural advantages.

The Jimenez Bridge, a wooden truss bridge of two 80-foot spans was completed on the 5th of March, the erection of the superstructure having been commenced January 9. Labor was scarce, and carpenters finally had to be secured from Oroquieta, Iligan, and Manila.

## BUKIDNON.

Bukidnon is certainly rich in natural resources, being the province which Commissioner Worcester selected as the best country in the Philippines for agricultural development. It is in this province

that the Philippines Development Company is operating. Other industries on smaller scale have been established, and the future grain and fodder and beef supply of the Philippines might easily come from this province.

All available funds possible are being devoted to providing transportation facilities, and to this end numerous cart trails have been constructed. A traction engine is to make the trip from Tinao to Tanculan, a distance of approximately 40 kilometers, for the Philippine Development Company.

Extreme drought has prevailed for the past seven months, and several of the wooden bridges on the Tinao-Balaybalay Road have been destroyed by fire.

Bukidnon Province is one of the few that has utilized the hydraulic ram to any great extent, each town being supplied with excellent water by this method. A comprehensive illustrated article on this subject is being prepared for the next issue of the BULLETIN.

## NUEVA ECTJA.

The contract for the construction of a standard market building 18 by 42 meters at Cuyapo, has been awarded to Tan Samco for the sum of ₱12,250.

Funds have been made available for the construction of markets in the municipalities of San Isidro and Peñaranda. Standard plans will be used in the construction of all the above markets with the addition of 1 meter to the length of the columns. The planned columns are too short for markets in this province, as the buildings would be too hot and too dark.

Five artesian wells have been completed in the municipalities of Cabanatuan and Nampicuan during this quarter. Bureau of Public Works rigs Nos. 17 and 19 are still employed, and it is expected to complete 27 artesian wells in this province during the present year.

The contractor's work upon the substructure of Talavera Bridge is progressing slowly, but unless conditions improve the substructure will not be completed in time to admit of the erection of the steel before the rainy season.

One and two-tenth kilometers of subgrade have been completed upon the Cabanatuan-Bongabong Road, and 2.8 kilometers upon the San Antonio-Jaen Road. The work upon these roads is being charged to maintenance of third-class roads.

Four kilometers of road have been completed upon the Guimba-Cuyapo section of the Manila-North Road since January 1, 1915, and funds have been received for the completion of the surfacing of this section.

Construction work was started on March 2 upon the Cabanatuan-Gapan section of the Manila-North Road, and the subgrade is now open for traffic between Cabanatuan and Santa Rosa. This shortens the distance between Cabanatuan and Santa Rosa by 2.3 kilometers and will permit the Minatula Bridge to be used which was completed last year.

## OCCIDENTAL NEGROS.

Rapid progress is being made with the surfacing of the Hinigaran-Isabela Road. The work has been completed as far as the Binalbagan River crossing. The subgrade has been completed between the river and Isabela, a distance of 5 kilometers, and surfacing materials are being delivered for this stretch. It is expected that the surfacing into Isabela will be completed by the 1 of July. A dry-season crossing is being provided at the Binalbagan River for light automobile and other vehicle traffic. The Insular loan requested for a permanent bridge over this road has not yet been approved.

Sufficient funds are available for surfacing 2.5 kilometers of road between the Najalin River and Antipolo on the La Carlota-La Castellana Road. Materials are now being delivered for this work.

The surfacing of the section from kilometers 27.5 to 29.5 on the Valladolid-San Enrique Road has been completed.

The 7-span reinforced-concrete girder bridge over the Malijao River on the Alicante-Victorias Road is about 60 per cent completed. Work is progressing satisfactorily on the other two girder bridges on this road.

The driving of concrete piles for the Prize Bridge over the Tabigue River in Saravia will be completed April 1. The bridge should be completed June 1.

The timber collapsible bridge, 103.7 meters long, over the Malugo River will be completed April 1.

The subgrade work has been completed on the 5 kilometers of road between Biniquil and Kabankalan. Surfacing materials are being delivered, but this part of the work will necessarily be delayed considerably until after the present sugar season is over, when



tramways will be available for hauling. The 1st of May should see the surfacing work well under way and the work will be pushed to rapid completion after that time.

Work has been started on constructing subgrade between Hima-maylan and Biniquil, 9 kilometers of road. It is expected that funds will be available for surfacing this stretch of road the first part of next year.

Two kilometers of road from Patig to the port of Pulupandan are now being reconstructed and widened, preparatory to being surfaced.

Work on the new road from Victorias to Manapla is progressing very satisfactorily. This is to be a 10-kilometer road of first-class construction with all bridges and culverts of reinforced concrete. A special allotment of ₱50,000 was recently approved for this project, making a total of ₱101,000 available. The estimated cost of the road and bridges complete is ₱113,000.

The market tables and ticket booth in the La Carlota market have been completed and present a neat and sanitary appearance. This improvement seems to be much appreciated by the local people.

The Hinigaran market building has been completed and turned over to the local officials.

Actual construction work was begun on the San Carlos market building, size 24 by 42.8 meters, type B, the middle of February. The contract time for completing this building is July 3.

Work on the athletic grounds, including a quarter-mile race track, at the Bacolod High School has been completed.

#### ORIENTAL NEGROS.

Tanjay school and market are well on the road to completion and will probably be turned over by the contractor about the latter part of April.

The deep-well rig laid up for lack of funds the latter part of 1914 has again started work. The first well is being drilled in Sibulan. Later the machine will move north, drilling one or more wells in each municipality.

A standard 3 by 3 meter culvert has been built in kilometer 11 of the Dumaguete-South Road. This replaces an old wooden bridge which had become dangerous.

On the Bais-Tanjay Road  $3\frac{1}{2}$  kilometers have been surfaced. Grading is practically completed between Tanjay and Bais and will be started on the north side of Bais at once. Work has also been started on the first of six small culverts.

A survey and borings have been made of a bridge site at Bais River. It is probable that money will be appropriated and the bridge built during the present year.

In Siquijor Subprovince construction of the Maria-Campalanas Road as second class is just beginning. The work is light, consisting mostly in shaping and widening the present grade, putting in pipe culverts, and repairing old bridges. On completion of this work every municipality on the island will be connected by a good road with Larena, the capital and port.

#### PAMPANGA.

Public works in Pampanga Province for this year will exceed all previous records.

Fifty per cent of the surfacing on the San Fernando-Calumpit section of the Manila-Tarlac Road is now complete. All the grading will be finished about May 1, 1915. Grading on the road is being done under the paquiao system, and costs about 20 centavos per cubic meter (loose). The method used in determining the cost of each 20-meter section is as follows: Add the center end fills in meters and multiply by 15, the result is the cost of the section in pesos. While this method does not give a uniform unit price (on account of the slopes) it nevertheless is fair as the preference is always for the greatest fill.

Between San Matias and the Pampanga boundary (12 kilometers) there are five tangents, the longest being 3,700 meters in length.

On account of the better and safer alignment, several large culverts will have to be moved or extended. Five kilometers of new right of way was purchased, but owing to the shorter distance enough has been saved in the construction to pay for twice the amount of right of way required.

For the construction of the market road 150 meters in length, the municipality of San Fernando has deposited ₱675 with the provincial treasurer. The work is to be done under the supervision of the district engineer.

The Mexico School has been changed from plan No. 7 to a plan No. 10. This was made possible by adding an appropriation of ₱3,000

to the funds on hand at the completion of the seven units. As full data is not on hand, a detailed statement of costs will be given in the next Bulletin. The cost per unit will equal that of the Macabebe School.

The Macabebe School, plan No. 6, has been completed for ₱11,677.43 (exclusive Insular aid surcharge). Partitions are of concrete and the building is 30 centimeters higher than called for in the plans. Flooring is yacal, doors and windows are ipil. The price also includes the fill of 25 centimeters. The offices were omitted, but the wood-work in the entire building was painted. The material was shipped to Calumpit from Manila by rail and from there to the site (eight kilometers) by banca.

The Baruya School, plan No. 3, municipality of Lubao, near the Bataan boundary, has been let by contract for the sum of ₱6,500.

The sum of ₱36,000 has been deposited with the provincial treasurer for the construction of a plan No. 20 (revised) school for the municipality of San Fernando. It is estimated that 16 units of this plan can be constructed with the money available.

Request for the Magalan School, plan No. 6, and for the Sexmoan School, plan No. 4, are now in the hands of the Director of Education for approval.

It is also expected that sites will be selected and municipal funds deposited for plan No. 6 Gabaldon schools in each of the following municipalities: Arayat, Candaba, and Guagua (Betis).

#### PANGASINAN.

Well rig No. 8, after having been laid up in Anda since December, 1914, has again started work. It has been assigned to the municipalities of Lingayen, Salasa, and Mangatarem.

Well rig No. 23 is drilling well No. 2 in Manaoag after having completed two very successful flowing wells in Mangaldan.

The San Jose Bridge, a reinforced-concrete pile and girder trestle, consisting of five 7.5-meter spans, was opened to traffic on April 1. Considerable difficulty was encountered in driving piles upon this job, as the bottom of the river was overlaid with a great number of old dungon, molave, and coconut piles, the stumps of which had to be pulled at considerable expense.

Bridges similar in every respect, except length of piles, to the San Jose are now being constructed on kilometer 11 of the Lingayen-Mangatarem Road, and kilometer 9 of the Pangasinan section of the Manila-North Road in Rosales. The construction fund for the former bridge was received from the Insular Government as a prize for the best maintained first-class roads in the fiscal year 1913-1914.

Surveys have been completed for 70 kilometers of road during the first quarter of the year. Construction has already been started upon a number of these roads.

A contract for the construction of 17 culverts upon the Manila-North Road, with a total length of 52 meters, was given to Tan Samco of Manila on March 22. Mr. Tan Samco's bid was ₱20,934, while the only other bid, that of M. E. Martin was ₱24,150. The work upon these culverts is to be finished before the rainy season.

The construction of a plan No. 10 standard school building is being started in the municipality of Alaminos.

The construction of a plan No. 6 standard school building has been started in the municipality of Bolinao. The sand and gravel for this work is being furnished by the citizens free of charge.

The construction of a plan No. 10 standard school building is being begun in the municipality of Umingan.

It is intended to advertise shortly for bids for the construction of a standard market building in Tayug. Funds have been appropriated, but all of the market site has not been purchased.

On April 1 only 3 kilometers of the Lingayen-Mangatarem Road remained uncompleted. The entire 29.1 kilometers of the road will be opened to traffic on July 1 as a first-class road.

On the 1st of April the Calvo Bridge at Bayambang across the Agno River was completed with the exception of laying one-half of the ipil floor. This is a four-span, steel-truss bridge on solid concrete piers. The total span is 520 feet. It is the intention of the officials of Bayambang to dedicate the structure on April 24.

The reconstruction of the Bautista-Alcala Road was completed in February. A high and broad dike was constructed on the right of way, on top of which was placed a 7-meter width of surfacing. This dike is to prevent the Agno River floods from crossing and destroying the road each year.

The citizens of Villasis are constructing 10 kilometers of the Villasis-Malasiqui Road by voluntary labor. At the last inspection made by the district engineer, the first 5 kilometers were under construction, being about 50 per cent completed. The work is being done under supervision furnished by the district engineer.

The citizens of San Nicolas have partially completed the construction of a plan No. 10 school building, using first and second group lumber, by voluntary labor and contributions. This building differs from the standard plan No. 10 in that the only concrete used is in the footings. The present value of the building is approximately ₱7,000. The district engineer has been requested to complete the building if it is possible to secure Gabaldon funds for the work.

The repair work, originally specified for the Mangatarem presidentialia, has been completed. The municipal council, being desirous of placing the entire structure in first-class condition, has appropriated additional funds.

The Mangaldan market building has been completed and is ready for occupancy by the municipality. The council, however, is desirous of constructing tiendas and a fence.

The Binalanon market is nearly finished. The contractor has been instructed to place market tables in the building before placing the concrete floor. On account of this, the building will not be ready for use before May 1.

The municipal council of San Fabian has requested authority to use the balance remaining in the market loan in placing a wire fence around the building which was completed recently, and to drill an artesian well upon the market site.

All concrete columns have been placed for the Rosales market. The contractor is now framing the roof trusses on the ground.

Rapid progress is being made with the construction of the Calasiao-Santa Barbara Road. Señores Maramba and Espino have rendered considerable assistance in securing right of way and laborers.

Construction of the Dagupan-San Carlos-Bayambang, the Tayug-Santa Maria, the Rosales-Umingan, and the Bautista-Oaoa Roads have been started, and it is hoped that considerable progress will have been made by July 1.

#### RIZAL.

The contract for the construction of the Pasig Provincial High School was awarded to Mr. Pietro Caronna on the 15th of January. Due to the contractor's inability to secure tested cement, construction was not actually started until the last of February. Concrete is being placed rapidly, however, and it is believed that the building will be completed in contract time which expires the 25th of September. The building is a modified plan No. 20. The contract price is ₱59,900.

Materials for the construction of the Antipolo kioskos were all received by the beginning of January, and construction was started at once, with a subcontract for supplying the labor. Work has progressed very favorably, and the kioskos will be ready for occupancy in time for the annual fiesta and pilgrimage which begins early in April. The object comprises the construction of two blocks of five 4 by 4 meter tiendas, and the grading and parking of the public park and plaza in front of the church.

A ticket booth and several tables have been constructed in the Pasay assembly market by Alvaro Victorio, a local contractor, at a price of ₱2,050. These tables comprise 4 concrete fish tables 90 centimeters by 8 meters, 8 concrete meat tables 90 centimeters by 8 meters, and 12 wooden-top fruit and vegetable tables of the same size. All tables are provided with 2-inch galvanized-iron pipe rails for display purposes. The total cost of the project, including inspection, is ₱2,330.41. An artesian well has been drilled on the market ground and it is proposed to install a small gasoline engine to pump into two storage tanks placed on a tower behind the market building.

The division superintendent of schools has been furnished with a preliminary estimate of the cost of a 4-room standard schoolhouse in Taytay, and a plan No. 6 standard schoolhouse in Parañaque. It is understood that allotments have been made by the Director of Education for these two projects, and construction by administration will be authorized at once.

The sum of ₱5,000 has been made available for the extension of the present telephone system in order to connect all towns of the province. Those located around the city of Manila will be connected to the Manila Telephone Company's central, while those east of Pasig will be connected with the Pasig provincial central.

Various minor repairs to public buildings and grounds in the province have been carried on by the district engineer during the last quarter.

The provincial budget provides the sum of ₱8,000 for the repair and maintenance of existing bridges and culverts. There are a great number of adobe-masonry structures that have had little attention for several years. These are being repaired and placed in good condition as rapidly as possible. Repairs consist chiefly of replacing with concrete adobe blocks which are dropped out of arches and pointing up the cracks left by the decay of old Spanish mortar. In some cases, however, a great portion of the bridge foundations have been carried away, and it has been necessary to place sheet piling, clear out under the foundations to solid bearing, and fill in with concrete.

A contract has just been placed for supplying by water transportation road maintenance gravel at various places in the province. The price f. o. b. cars at McKinley is ₱1.45 a cubic meter. No trouble has been experienced during the quarter in securing adequate railroad transportation. As a result, all road depositories are plentifully supplied with maintenance gravel, and there is a good supply in the general depository of each road for use during the coming rainy season. The provincial road maintenance fund has been augmented by an Insular allotment to maintain the heavily traveled roads around the city of Manila. Maintenance money is plentiful, and a good deal of reconstruction and road betterment is being carried on. One road roller is employed constantly on resurfacing. The asphalt section of the Manila-South Road is being repaired with material that has just recently arrived from the United States. Road oil is on requisition for the oiling of various low-lying sections of roads that are inundated annually.

The municipality of Pasay appropriated ₱4,500 to be used in the reconstruction of streets additional to those built last year. This work was completed in January. All road construction and maintenance in this municipality is being supervised by the regular provincial road organization to the entire satisfaction of the municipality.

A contract has been awarded to Gregorio de Silva, a local contractor, for the construction of the Taguig and Buting timber trestle bridges on the Taguig River. The contractor is assembling his equipment and materials and will begin construction shortly.

Early in the year the Angono-Binangonan Road was opened for light traffic by the repair of all temporary bridges. This road connects the plant of the Rizal Cement Company with the city of Manila. The company's heavy traffic goes by water transportation, but it is a great convenience to them to be able, now, to communicate with Manila in an hour's time by an automobile. The province intends making this road first class during the present year; ₱59,000 is available for this work, and an additional ₱50,000 is in sight with which to continue the construction to Morong, and thus open up all towns in the province to automobile communication. A very good grade of hand-broken stone is being secured on the project at a price of 80 centavos per cubic meter. Three concrete-pile bridges are included in the proposed work.

#### SAMAR.

As forecasted in the latter part of last year, Samar Province will have sufficient road and bridge funds to insure an abundance of work through the year. Two new roads are in prospect, viz., the Catbalogan-South Road to Wright, some 30-odd kilometers and the Catbalogan-North Road, which will complete the unfinished section between the capital and Calbayog.

The Calbayog-North Road, 6.7 kilometers, to the barrio of Sabang, has been practically completed and opened to traffic. Work has now begun on the culverts and bridges on the old Spanish right of way from Sabang to Oquendo.

Work has also been opened up on a short section of 2 kilometers on the east coast. This will complete the first-class road from Borongan to Sulat.

The Catubig school building, No. 7, has been finished.

Plans are under way to put a coral surfacing on the Carangian-Laoang Road, 67 kilometers, in order to enable automobiles to operate with greater ease than at present. This is a third-class road, except the first 18 kilometers which has been declared second class. If conditions permit, a 10-ton steam roller will be shipped to this district to roll the coral rock.

On the Ainsworth contract, six bridges have been completed, and four opened to traffic, the approaches to the remaining two not yet being in. The seventh, and last bridge, the Bachow, is now well under way.

Contractor O. Stephens has just completed the Calbayog market building. This project consists of one large building, one small open-type tienda building, and one double-tienda building of twelve

4 by 6 meter rooms. Calbayog Bridge is a 5-span, 7-meter slab and girder, superstructure on reinforced-concrete piles. The same contractor will go in a few days to the east coast where he will undertake the erection of a No. 7 schoolhouse at Oras and a No. 3 schoolhouse at Dolores. Mr. Stephens is a man who does excellent work.

#### SORSOGON.

Since the 1st of January the number of camineros in this province has been reduced so that, on an average, there will be about 3 camineros to 5 kilometers of road; some camineros having as little as 1 kilometer and one having as much as 2.7 kilometers. The camineros' sections have been divided so that each caminero will have at all times sufficient work to keep him busy in maintaining his section under ordinary conditions.

During the last three months 4 kilometers on the Sorsogon-Bacon Road have been resurfaced and on the Bulan-Irocin Road an extra gang has been steadily working to repair kilometer 18, which was practically destroyed by the heavy rains of last year.

The artesian well in Irocin has been sunk to a depth of over 500 feet, but without any result so far.

The construction of the Sorsogon-South Road has been advanced so that surfacing has been completed to the barrio of Ariman (kilometer 20.5). Rock has been delivered as far as the barrio of Malobago (kilometer 25) and, except for one culvert on kilometer 29, all bridge construction has been finished up to the end of kilometer 38. It is expected that during the next three months the road will be open for auto traffic from Gubat to Bulusan.

While the road from Bulan to Irocin was being constructed, a provisional pile bridge was built on kilometer 19 in the barrio of Buenavista. During the last year this bridge became unserviceable under the increase of traffic, and in consequence was replaced by another provisional bridge consisting of piles, girders, stringers, and floor of ipil; the total cost for six bents, of three piles each, 5 meters center, being ₱672. The round ipil piles would have squared 12 by 12 inches by 5 meters long and were purchased for ₱3 apiece. Ipil logs for 16 by 14 inches by 5 meters long were purchased for ₱5 apiece.

A new grand stand is being built by contract under the supervision of the district engineer for the coming Bicol meet. It will be capable of seating 1,000 people, will cost about ₱3,500, and will be completed by the end of March. All posts are of first-group timber imbedded in concrete and all frame timbers of guijo; the roof will be of galvanized iron and will be attached to the trusses in the same way as the roof of a Gabaldon school building.

#### SURIGAO.

[Nothing received from the district engineer of Surigao.]

#### SULU.

Fourteen thousand pesos have been appropriated for the completion of the Sulu Public Hospital at Jolo. Work has commenced on the concrete footings and piers and is proceeding favorably.

Bids were opened February 15, 1915, for the lumber, and contract awarded to the lowest bidder, the Basilan Lumber Company.

Foreman Sherman is in charge of 200 men on the Seit Lake Road cutting grass, placing temporary bridges, and making it generally fit for traffic. Ten kilometers is open to traffic now. It is surmised that the opening of this road will have a great civilizing effect upon the natives, as many of them have never seen an automobile.

The municipal streets of Jolo are rapidly being covered with coral. Three thousand pesos have been appropriated by the municipal council for this work and placed under the supervision of the district engineer. The results seem very satisfactory.

A 1,500,000-gallon water source has been found  $2\frac{1}{2}$  kilometers from Jolo for the town of Jolo. A topographic survey has been made for the pipe line and of the water shed. A tract has been surveyed by the Bureau of Lands, and action is being taken to have it set aside as a public reserve. Necessary data is being gotten for the development of the system.

Poles have been cut for the Jolo-Seit Lake-Bual telephone line, and the work of setting will start immediately.

The Jolo-Maimbung and Jolo-Parang Roads are under rigid maintenance, and actual construction will begin as soon as our new roller arrives.

#### TARLAC.

The survey of the site of the proposed bridge over the Santiago River is now completed. This bridge will connect the municipalities of Capas and Concepcion and it is quite important because it will be a part of the road from Tarlac to Pampanga.

Survey on the Tarlac-Nueva Ecija Interprovincial Road will soon be undertaken. The project will probably cost ₱100,000—about ₱65,000 for the Tarlac side and ₱35,000 for the Nueva Ecija side.

The No. 3 schoolhouse in the barrio of Bani, in the municipality of Paniqui, is now completed at a total cost of ₱7,033.29, including surcharges.

A No. 2 schoolhouse in the barrio of Sinilian, in the municipality of Camiling, is now under construction.

Construction of tables in all the modern market buildings in the province is now going on.

The Tarlac-La Paz Road is open to carromata traffic. La Paz is a town 21.2 kilometers from Tarlac and it is very rich in palay.

The wooden bridge on the San Isidro Creek between the municipalities of Paniqui and Moncada is nearing completion. Upon the completion of the bridge, the road from Tarlac to Moncada will be made continuous without interruption for a distance of 37.5 kilometers.

#### TAYABAS.

Construction of Tayabas-Lucban Road has been started. This project will cost nearly ₱100,000 and involves heavy grading work, as the road penetrates the foothills of Mount Banahao. Fortunately, the only large rivers are already bridged with old Spanish arches or modern structures. As practically all labor has to be secured from adjoining provinces, it will require some time to develop a large permanent force for this work. It has been found necessary to supply quinine and other simple remedies to camp foremen, under the supervision of the district health officer, as many of the laborers have suffered from the dampness and cold occasioned by the high altitude.

The old high-school building, located on the provincial grounds at Lucena, has been torn down and removed by a contractor, who bought it for the materials he might salvage for ₱200. This structure was erected in 1906 and was a 2-story building composed of Oregon pine, with shell windows and sheet-iron roof. Any had so attacked the building that the windows, a few hardwood harigues, and the roofing iron were the only remaining serviceable materials obtained by the contractor. It thus appears that the province paid approximately ₱26,970 for the use of 800 square meters of floor space for eight years. No more convincing argument in favor of permanent construction, even at high first cost, could be advanced.

The province is making arrangements for the purchase of a truck to be used on construction and maintenance work. This will help to solve one of the greatest problems in the economical prosecution of public works in Tayabas, as bull carts are scarce and always busily employed on private business. The vacas originally bought for use on the construction of the Atimonan Road, many of which have been in service nearly eight years, are being sold at auction. They bring good prices, as they have been fattening nearly a year. It is intended to purchase a few young bulls with the proceeds of these sales and to use the new animals on maintenance work where the truck cannot operate economically.

The main building for Lucena market has been completed with the exception of the placing of a small amount of roofing iron. It was found necessary to support one side of the fill for this structure by a concrete retaining wall about 5 feet high. The tiendas are 50 per cent completed.

Mauban market, a type B, 21.5 by 43.5 building, should be completed by March 15. This work has proved very costly because of the heavy fill and difficulty in obtaining materials.

Surveys have been made and a private concern is now planning the installation of an hydro-electric plant for the town of Lucban. The project is apparently entirely feasible and will greatly enhance the many natural advantages now enjoyed by the inhabitants of the "Baguio of Tayabas."

Considerable construction work is now being carried on in the larger towns of the province by private parties, such as dwellings and warehouses. It is interesting to note that where harigues are still used, care is taken to secure straight dressed lumber of the first group and that the framing is more substantial and constructed in a more workmanlike manner than formerly. In many cases reinforced concrete is being used and the roofing is invariably of galvanized iron.

Funds will soon be available for constructing a portion of the road to connect the railroad with Unisan. This is part of a project which contemplates the construction of a road along the coast of the Bondoc Peninsula to connect Unisan, Pitogo, and Mulanay with the railroad.

Bids have been opened for the construction of a matadero for the municipality of Sariaya. This building, with a block of tiendas and the already completed market building, will make the most complete market plant in the province.

Mr. John Gordon, the successful bidder for the construction of a 21.5 by 43.5 type B market at Tayabas, has started work, and, with reasonable success in obtaining labor and materials, should be able to complete the building within two and one-half months. The site is very favorable for construction purposes.

#### MARINDUQUE.

Plans and data for a pile bridge north of Gasan, Marinduque, have been submitted. This structure will enable residents of Boac and Gasan to use automobiles and will stimulate traffic, as the present ford is impassable for motor vehicles at high tide.

Funds have been appropriated to complete the road south of Boac as far as Buenavista. A small amount has been made available to repair the Buenavista-Torrijos Trail. The trail from Buenavista to the hot springs at Malbog will be improved with maintenance funds.

#### ZAMBALES.

Delayap Bridge No. 16.5, a three 6-meter span, reinforced-concrete pile structure, was completed in January.

All the concrete work on the Dinumagat Bridge is completed. This is the longest permanent bridge in the province, being a six 7-meter span girder on pile bents.

Concrete piles are being driven for the Pamatauan Bridge which is to be a six 7-meter span structure. This will be the last permanent structure on the Iba-South Road to be constructed, and with its completion the province will have a continuous road 36 kilometers in length with all the streams bridged with concrete structures. Great satisfaction is shown by the people of that part of the province.

The construction of the Bangantalinga culverts, a 5 by 4.5 meter double-span structure, is well under way.

Requisitions for materials have been forwarded for three large culverts on the road between Candelaria and Santa Cruz. The provincial authorities have decided to apply the regular allotment for this year to the construction of three rectangular culverts and one girder bridge on this road.

The survey of a new road from Iba to Masinloc is nearing completion.

A pumping well in Botolan was driven during the quarter.

#### GENERAL ITEMS.

##### THE UTILITY OF PUBLIC ROADS IN PAMPANGA PROVINCE.

##### *Traffic census, Pampanga Province.*

[Taken within 24 hours only, March, 1915.]

Road.	Pedestrians.	Carts.	Carromatas.	Horses and carabaos.	Bicycles, autos, and motorcycles.
Angeles-Porac	1,313	155	150	103	12
San Fernando-Santo Tomas	2,515	42	141	53	42
San Fernando-Bacolor	2,526	415	915	61	241
San Fernando-Mexico	1,680	152	338	26	71
Mexico-Santa Ana	95	38	26	20	4
Santa Ana-Arayat	291	13	17	21	15
Bacolor-Guagua	1,838	140	360	67	45
Guagua-Lubao	1,238	272	431	132	21
Lubao-Floridablanca	125	110	4	140	-----
Guagua-Santa Rita	2,077	185	263	82	17
San Fernando-Calulut	1,954	306	176	32	27
Santa Ana-Candaba	179	6	15	13	-----
Apalit-Macabebe	370	1	122	6	7
Apalit-Calumpit	605	4	55	2	14
Guagua-Sexmoan	1,608	1	63	5	13
San Matias-Apalit	628	5	59	7	5
Angeles-San Fernando	792	66	32	44	12
San Simon-Apalit	539	-----	146	19	-----
San Simon-San Luis	356	-----	53	-----	2
San Luis-Candaba	203	26	14	6	9
San Luis-Santo Domingo (Mexico)	238	4	10	28	-----
Apalit Station-San Vicente	678	10	248	11	7
Apalit Station-Macabebe	390	7	106	14	13

#### REPORT OF THE DISTRICT ENGINEERS' CONFERENCE HELD AT BAGUIO FEBRUARY 8-16, 1915.

By W. C. WEST, Assoc. Mem. Am. Soc. C. E.

Preparation for the Conference began early in November, 1914, with a circular letter from the chief constructing engineer to each district engineer, presenting the following tentative list of subjects for discussion in the conference:

1. On the selection and preparation of data for bridges and buildings.
2. Estimates: Methods of preparation; proper relation between engineer's estimate and contractor's bid; personal successes and failures with apparent reasons for same.
3. The engineer's technical library.
4. The future of irrigation in the Islands; opinions and recommendations as to how the work should be handled.
5. Right of way matters: Why fifteen meters? What about the future? Should the right of way be paid for or not?
6. Binders for water-bound gravel surfacing.
7. Relative value of gravel and broken stone; are we using the road materials best adapted to our needs?
8. Market construction: Layout of the work; economy of using precast columns; recommended changes in specifications; selection of site.
9. School building construction: Layout; recommended changes in plan and specifications; selection of site.
10. Important laws with which every district engineer should be familiar.
11. Philippine woods: How many do you know and how do you know them?
12. Engineering relations between contractor and engineer; character and amount of inspection necessary.
13. Road maintenance: Size of material used; economic value of a neat appearance for the road; the continuous system of repairs to surfacing *vs.* the intermittent system.
14. Overflow sections: Experiences and criticisms.
15. Contract *vs.* administration results. Correct attitude toward provincial and municipal resolutions requiring the district engineer's guaranty to construct within the estimate.
16. District engineers assistance in well drilling operations.

A few weeks later each district engineer was requested to submit an informal written discussion of these subjects, same to be submitted to the chief constructing engineer on or before January 1, 1915, in order that abstracts might be made and copies placed in the hands of each district engineer at the opening of the conference. It was found to be impracticable to print these discussions as intended, but they were read, eliminating duplications, as the conference progressed, and are considered for purposes of this report as a part of the proceedings of the conference.

A regular program was proposed, covering the following subjects, which were taken up and discussed in the order named:

1. Assistance in well drilling operations. Results during the past year and suggestions for the present year.
2. The engineer's technical library.
3. Road overflow sections.
4. The construction of broken-stone macadam roads with special reference to the sizes of stone to be used, the permissible binders, the proper crown, and the necessary thickness of the finished road crust.
5. The construction of gravel roads with special reference to the grading of the various courses, the binder, and the thickness of the finished road crust.
6. Tar and asphalt macadams and oiled sections. Report on existing sections, with suggestions as to improvements in methods of laying of section used and a discussion of the proper place for asphalt and tar macadams in the Philippine Islands.
7. Concrete, brick, and sheet asphalt pavements. Present States practice and suggestions as to the probable uses for these pavements in the Philippine Islands.
8. The economics of highway construction.
9. Road maintenance: The caminero system *vs.* the intermittent system.

10. Bridge floors; Can the weight of concrete floors be lightened if wood or bituminous concrete wearing surfaces are substituted for the present wearing surfaces?
11. Reinforced-concrete pile bridges: Improvements in construction methods and discussion of what constitutes a proper plant.
12. The preservation of iron and steel structures.
13. The selection and presentation of data for bridges and buildings.
14. The preparation of estimates; methods used and accuracy secured.
15. Specifications: Suggestions as to necessary changes.
16. The proportioning, mixing, and placing of concrete; proper methods and practices.
17. Unit construction of market columns.
18. Under what conditions should administration work be recommended in preference to contract work?
19. The engineering relations that should exist between the contractor and the district engineer.
20. When is a right of way width of less than 15 meters justified? What compensation is recommended? Laws and proposed legislation.
21. Important laws affecting district office administration.
22. Relations with local authorities. Surcharges, authorized personnel, etc. Provincial engineer *vs.* district engineer.
23. Licensing of civil engineers.

The program named a separate committee for each subject. The members of the committee spoke at the invitation of the chairman, and afterwards the subject was opened for general discussion. Duplication of matter was avoided by subdividing the subject among the members of the committee. Every man had evidently come with pretty clear ideas of what he wanted to say, and the discussions were animated, instructive, and eminently practical.

The conference met promptly at 8 a. m. on February 8 in the Executive Building, Government Center, and organized for work with H. F. Cameron as chairman and F. T. James as secretary. Upon Miss Lindell Hoskins fell most of the work of recording the discussions, and to her copious notes is due the greater part of any success which may attend this report. E. J. Westerhouse, chief constructing engineer, was injured in an automobile accident while on his way to Baguio, and was unable to be present until the conference was nearly over. Following is the complete list of engineers attending the conference: Romarico Agcaoli, A. W. Austin, Sotero Baluyot, J. R. Barry, R. L. Barry, N. Richmond Baugh, C. R. Bennett, L. S. Boggess, E. C. Brown, L. R. Brown, H. F. Cameron, G. B. Canaga, John H. Caton III, L. T. Clark, J. C. Cockingham, C. S. Dandois, Luis Francisco, R. V. Glenn, Pastor Gomez, C. E. Gordon, I. R. Grosvenor, E. J. Halsema, J. L. Harrison, Leon Ines, F. T. James, Marcial Kasilag, Henry B. Lilley, Antonio Manuel y Tayzon, S. L. McGlathery, H. R. Meehleib, C. G. Morrison, Claud Russell, L. W. Scheidemantel, Valeriano Segura, A. H. Sjovall, E. D. Smith, A. T. Sylvester, Julian Vallarta, J. W. Vickers, W. C. West, E. J. Westerhouse, A. D. Williams.

#### ARTESIAN WELLS.

*Committee.*—Vallarta, Grosvenor, Lilley, Caton, L. R. Brown.

The present system of divided supervision and responsibility, with reference to drilling operations, has been in force for about a year, and has worked as well as could have been expected. The old system, with the wells completely under the supervision of the chief of the division of artesian wells, and also a radical departure therefrom, by which the work should be placed entirely in the hands of the district engineer, were both thoroughly discussed, and both rejected as being inferior to a compromise system. It was the consensus of opinion, however, that the district engineer should be given control over a few more details, in order that his power might be more nearly commensurate with his responsibility, hence the following resolution was passed:

Whereas, the present system relative to the drilling of artesian wells is in general satisfactory and should be continued, but that certain features of the present system should be emphasized and certain additional instruction should issue, it is hereby

*Resolved*, (1) That the district engineer should arrange for the necessary provincial or municipal funds and resolutions, and for the location of wells as heretofore.

(2) That all well-drilling foremen should be directly under the instructions of the district engineer in all matters appertaining to well drilling, except the technical supervision of the actual well drilling. If at any time the Director should deem it necessary to give instructions direct to the well driller, a copy of such instructions should be furnished the district engineer.

(3) That the well-drilling foreman should forward all samples of water and strata direct to Manila, and not through the district engineer, unless otherwise instructed.

(4) That the district engineer should approve all vouchers, time records, and requisitions of the well-drilling foreman and his personnel, and forward them to Manila as heretofore.

(5) That the artesian well division should supply the district engineer with all data as to cost of well and analysis of water as soon as practicable.

(6) That the district engineer should be instructed to report upon the conduct of the well-drilling foremen in his district, and to recommend any administrative action deemed necessary.

#### THE ENGINEER'S TECHNICAL LIBRARY.

*Committee.*—Harrison, Glenn, West.

The following resolution was adopted by the conference:

Whereas, every district engineer should have at his disposal an adequate, but limited, technical library, consisting of texts specially related to district work, such library to be a part of the office equipment, the same as maps, plans, instruments; etc., and

Whereas, it is believed that the Bureau library in Manila could be of greater benefit and help to the district engineer, it is hereby *Resolved*, (1) That the advisability of suggesting to provincial boards the purchase of moderate libraries for the office of the district engineer should be taken under consideration.

(2) That the following texts are recommended: American Civil Engineer's Pocket Book, by Merriman or Trautwine; Electrical Engineers Handbook, by Foster; Architects and Builders Handbook, by Kidder; Surveying, by Johnson; Concrete, Plain and Reinforced, by Taylor & Thompson; Engineering Jurisprudence, by Johnson or Wait; Structural Steel Handbook, by Cambria or Carnegie; Handbook of Mechanical Engineering, by Kent; Engineering Geology, by Ries & Watson; Subaqueous Foundations, by Fowler; Water Supply Engineering, by Turneure and Russell; Highway Engineers Handbook, by Harger & Bonney.

(3) That the Bureau library at Manila should be enlarged as rapidly as possible, that a list of its books should be filed in all district offices, and that the librarian should be instructed to prepare, when requested, lists of references, on any engineering subject desired, to books and periodicals contained in the Bureau library and also in the Philippine Library.

(4) That arrangements should be made whereby any engineer of the Bureau may take out books from both the Bureau and Philippine Libraries, retaining them for a reasonable period.

Besides the texts mentioned in the resolution, the following were recommended by individual engineers:

*Periodicals.*—Official Gazette; Engineering News; Engineering Record; Engineering and Contracting; Railway Age Gazette; Concrete-Cement Age; Bulletins Nos. 4, 10, and 11 of the Philippine Bureau of Forestry; Transactions of the Am. Soc. C. E.; B. P. W. Quarterly Bulletin.

*General.*—Cyclopedia of Civil Engineering of the American School of Correspondence; Patton's Civil Engineering.

*Logarithms.*—Vega; Jones.

*Concrete.*—Taylor & Thompson's Concrete Costs; Turneure & Maurer's Principals of Reinforced Concrete Construction.

*Handbooks.*—Gillette's Cost Data; B. P. W. Handbook.

*Masonry construction.*—Baker.

*Railroad field books.*—Nagle; Searles; Shunk; Webb's R. R. Construction.

*Physics.*—Carhart.

*Surveying.*—Merriman and Brooks.

*Structural steel design.*—Merriman & Jacoby's Roofs and Bridges; Ketchum's Structural Steel Handbook; Ketchum's Walls, Bins, and Grain Elevators; Ketchum's Design of Highway Bridges; Ketchum's Design of Mill Buildings; Greene's Trusses and Arches.

*Hydraulics.*—Merriman; Church; Savage's Water Supplies; Adams' Sewers and Drains; Thomas and Watt's The Improvement of Rivers.

*Mechanics.*—Merriman; Church; Greene's Structural Mechanics.

*Highways.*—Baker's Roads and Pavements; Byrne's Highway Construction; Byrne's Inspector's Handbook; Gillette's Rock Excavation; Gillette's Earthwork and its Cost; Frost's The Art of Roadmaking.



*Irrigation.*—Wilson.

*Geology.*—Chamberlain; Eckel's Tables of Mineral Properties.

*Tunneling.*—Brunton and Davis's Modern Tunneling.

A district library has already been started in the Rizal office with the coöperation of the provincial board, and the general opinion seemed to be that the only reason for the present dearth of district libraries is that the provincial boards have not been asked to appropriate the necessary funds.

#### ROAD OVERFLOW SECTIONS.

*Committee.*—Dandois, Baluyot, Morrison, Bennett, Clark.

"Overflow section," as defined by one of the speakers, is "the name applied to a section of road subjected to periodical inundations, generally two or three times a year." Three general cases were cited in the papers and discussions: (a) Meandering rivers, where the channel requiring a bridge in the dry season and during ordinary floods is only one-half to one-fourth the width of the section flooded at least once every year; (b) inadequate ditches and culverts—that is, inadequate for the excessive rainfall which occurs during severe typhoons; and (c) flat country, where road and all becomes entirely covered with water, at times several feet deep. In the latter case, the water sometimes flows across the road in one direction while rising and in the other when subsiding.

There are three methods of treating these conditions: (a) By building an embankment sufficiently high that the water cannot rise above it; (b) by a viaduct; and (c) by so treating the surfacing and subgrade that they are able to withstand the scouring action of the flowing water.

The certainty that a high embankment will act as a dam, and that it will have its stability endangered by the inevitable percolation beneath it, together with the enormous expense of its construction, generally puts the high embankment out of the question as a method of dealing with the problem. The viaduct can be built so as to insure stability, but here again the high cost is usually prohibitive, hence the method of treating the road so as to let the floods pass over it is about the only one left to the engineer. Two general methods were proposed as having proved effective in specific instances: (a) Oiled or asphalted macadam, or concrete surfacing; and (b) a dike on the downstream shoulder.

All the experiments so far conducted in the Islands with oiled or asphalted macadam have been by regular penetration methods, familiar to every engineer. In general, it may be said that asphalted overflow sections have proved fairly successful in locations where the flood water does not remain on the road longer than one day at a time, and where the subgrade is well drained. Where asphalted macadam is submerged for long periods, and especially where it is subjected to wheeled traffic while submerged or saturated from a wet subgrade, the asphaltic compound deteriorates through emulsification, and the surfacing rapidly goes to pieces. Concrete pavement is not open to these objections, but is subject to certain others peculiarly its own, and is always high priced.

The dike method bases its claim to effectiveness upon the proposition that water-based macadam is not injured by being submerged, provided the water actually in contact with the metaling is not in motion. Hence, the downstream shoulder is raised from 10 to 25 centimeters above the crown, and the downstream side slope is sodded or riprapped against scour. Suggested limiting slopes are 1 on  $1\frac{1}{2}$  for upstream slopes, and 1 on 3 for downstream. Adobe stone pointed with concrete has been successfully used as riprap in Bataan Province. The crown, for best results, should be very flat, or even entirely absent.

#### BROKEN STONE MACADAM.

*Committee.*—Halsema, Russell, Glenn, J. R. Barry.

*Subgrade.*—Mr. Barry's paper especially emphasized this point, and several of the other speakers mentioned it, all agreeing as to the importance of a solid, well-rolled subgrade. Some advocated the practice of allowing the fills to stand over one rainy season in order to take advantage of the compacting effect of the rains; especially important where the fills are short and high and alternate with cuts. Others roll their fills in 50-centimeter layers, and have no

further trouble as to settling. One device for lowland rice-paddy country is to build the embankment entire and then spread a six-inch layer of a sand-clay mixture, 1 part clay to 3 parts sand, before rolling. By this method subgrade work can be carried on during the rainy season.

*Methods of construction.*—The Los Baños Quarry uses a single size screen, thus producing only two sizes of stone—crusher run and screenings. The method of placing the stone is substantially as follows: (a) Lay the stone in a single course to the proper depth; (b) roll dry and fill depressions; (c) water and roll until no "wave" is perceptible; (d) spread, water, and roll a thin course of screenings, adding more, a little at a time, until the stone will take up no more of the screenings; (e) spread, water, and roll a wearing coat of screenings to finish the work. The same method is followed in Iloilo with a very hard basalt, except that the first course of screenings placed consists of soft limestone. The second, or wearing course, is  $\frac{1}{2}$  inch of basalt screenings.

In Batangas the locally crushed stone is screened to three sizes, laid in two distinct courses, and finished with a screenings course applied all at once. The force is so organized as to keep the 10-ton roller busy, and results in the laying complete of 400 square meters of surfacing per day.

Hand-broken stone produces but little screenings, never sufficient to bind hard stone, but it will often prove economical to use it, employing the same binders as would be used for gravel. Crushing may generally be done cheaper by machinery than by hand, but the immobility of the crushing plant often makes transportation charges the determining factor. Broken-stone screenings, however, is conceded to be the best binder for broken-stone macadam, and should be used wherever economically possible.

*Crown.*—The trend of opinion was decidedly in the direction of the flat crown, as is shown by the following resolution which was adopted by the conference:

*Resolved* (1) That the crown of the road should not exceed  $\frac{1}{2}$  inch to the foot, and generally should be slightly less. Where the profile grade, however, is greater than  $\frac{1}{2}$  inch to the foot, the crown should not be less than the profile grade, but not greater than  $\frac{1}{4}$  inch to the foot. In city streets the crown should be sufficient to keep the surfacing above the ordinary water level of the gutters.

(2) That upon the sharper curves of roads subjected to considerable motor-vehicle traffic, the crown should gradually pass into the superelevation of the outside of the road.

*Gravel vs. broken stone.*—As one writer expressed it, "it is a question of economy in construction and maintenance." With the latter in mind, at least three of the district engineers stated their preference for broken stone over gravel up to an advance in the cost of material of 100 per cent over the cost of gravel. Opinion was practically unanimous that with pebbles and stone of equal hardness and first cost equal, or but slightly in favor of gravel, broken stone should be preferred.

#### GRAVEL ROADS.

*Committee.*—E. C. Brown, Austin, Morrison, Gomez, Smith, Meehleib, West.

*The gravel.*—The committee agreed upon the following as the chief characteristics to be sought in any gravel for road-building purposes:

(a) Hardness and toughness of pebbles sufficient to resist abrasion and fracture under traffic.

(b) Proper graduation of the pebbles and sand, as to sizes and proportions, so that the voids are reduced to a minimum.

(c) The presence of a suitable binding material.

It was pointed out in the discussion that where the pebbles are hard it is nearly always necessary to add some foreign material as binder, and that these binders rarely give entire satisfaction; hence the relative superiority of broken stone over gravel, for hard rock and hard pebbles. Between soft rock and soft gravel there is little difference in value.

*Screening.*—The necessity of screening was pretty generally agreed to by all the speakers, owing to the rarity of suitable natural mixtures, and also to the desire to use exact methods wherever possible, instead of rule of thumb. Experience has shown that with the or-



dinary wire gravel screen the size of mesh must be considerably larger than the maximum size of gravel it is required to pass. Thus, a 1½-inch screen is needed for ¾-inch gravel screenings, a 2½-inch screen for 2-inch gravel, etc.

*Placing and rolling.*—The depth to which gravel should be placed, and the number of courses, depend largely upon the bearing power of the finished subgrade and upon the weight and character of the traffic. Various widely different methods in more or less successful use were described, but the trend of opinion seemed to be in favor of thorough screening and three-course work, the first course to be composed of stones 3 inches in diameter and over; and of 20 centimeters as the minimum depth, loose, for the two gravel courses. This thickness of surfacing, when laid on a properly rolled subgrade, has proved its ability to support heavy auto trucks, whereas there have been instances of failure with courses thinner than this. Some engineers lay the first courses and subject them to the wear and compaction of traffic for some time before the top course is placed, others prefer to have the road complete before opening it to traffic. It is claimed that the former method will produce the smoother road and that the latter will require smaller additions of binding material.

*Binders.*—The consensus of opinion as to the almost universal necessity of adding a foreign material as binder was unmistakable. As to the material itself, however, it developed that each district engineer makes use of whatever is most economically available, such as volcanic ash with an iron oxide content, clay, sandy clay, yeso, soft limestone, coral sand, etc. The limitations of the straight clay binder were fully recognized, and the clay is generally mixed with sand in the proportions 3:2 or even 3:1 of sand and clay, respectively. The proportion of binder most generally favored for use with clean gravel was 15 to 20 per cent of the volume of the gravel. The binder is spread over each course of gravel and rolled in with the course.

#### BITUMINOUS MACADAM.

*Committee.*—Bennett, Morrison, Kasilag, Gordon, Agcaoili.

In this section were discussed the various bituminous binders for gravel and broken-stone macadam, applied by the penetration method exclusively.

The cold-oil treatment was characterized by one speaker as being cheap and capable of giving an excellent dustless surface in dry weather, but as having the disadvantage of forming an oily mud during the rainy season, very destructive to rubber tires. One application per year should be sufficient, with ordinary traffic.

The following penetration method was suggested for use with a heavy refined tar or asphaltic residuum:

1. Lay water-bound metaling complete, by regular methods. Roll with extreme thoroughness, and see that the metaling dries out thoroughly before applying the hot compound.
2. Brush out screenings to expose stone or gravel to a depth of 1 centimeter.
3. Heat oil to temperature of 300° to 400° F. Apply evenly, in the quantity of about three-fifths gallon per square meter.
4. Spread 2-centimeter layer of dustless stone screenings, rolling thoroughly with 8-ton tandem roller. Look out for waves in front of roller.

Two or three bituminous courses may be laid in the manner outlined above, according to traffic requirements.

Opinions were greatly divided as to whether bituminous construction is adapted to present conditions in the Philippines. The limitations of any asphaltic compound in the presence of excessive moisture were fully recognized, but, in view of the increasingly heavy demands being made upon our improved roads by motor trucks, the justifiability of further experiments with bituminous macadam was pretty generally conceded.

For esthetic and sanitary reasons some municipalities in Pampanga are insisting that the roads passing through *poblaciones* should be oiled, and they are willing to furnish the oil to the district engineer.

The Leyte asphalt deposit was discussed, and it was brought out that the material contains about double the proportion of paraffin that it should contain. The excess can be refined out, however. Ex-

periments on the Cebu wharf show that the crude material wears well, does not peel easily, but cracks.

#### THE ECONOMICS OF HIGHWAY CONSTRUCTION.

*Committee.*—Gordon, Cameron.

Mr. Cameron's paper emphasized the following points as making for the most economical expenditure of road funds in construction and maintenance, with the avowed object of obtaining the greatest possible kilometerage of roads completely built, equipped, and maintained for the funds available.

1. *Location.*—Careful surveys and investigations are always essential before deciding upon final location.

2. *Right of way.*—Adequate right of way should always be obtained in advance of construction, whether on old roads or with new locations.

3. *Natural quarry sites and gravel deposits.*—All these sites in the province, whether on roads to be built in the near future or not, should be set aside, by executive order or otherwise, for road purposes.

4. *Fords instead of expensive bridges.*—Where the depth of the water is not sufficient to interfere with the class of traffic for which the road was designed, a rock ford or a concrete asphalted overflow section may often be economically substituted for a bridge.

5. *Machinery.*—Where labor is cheap and plentiful, the purchase of expensive machinery is hardly ever advisable—at least, the burden of proof should rest with the advocate of the machinery.

6. *Foreign-produced materials.*—Transportation is always an important factor in road construction, hence local materials should always be used when they can be delivered more cheaply and will produce the same results.

7. *Large projects.*—In practically every instance the work is carried on more economically in large projects than in small ones; hence, the tendency to fritter away public funds on small, disconnected jobs must always be guarded against.

8. *Layout.*—The grading force and the rate of delivery of surfacing materials and water for sprinkling should be so adjusted as to keep the rolling equipment working at its maximum efficiency. Generally it will require more than two motor trucks to keep one roller busy.

9. *Design.*—The engineer, to be successful, must have a thorough knowledge of construction specifications for the different classes of work. It is poor policy and expensive to depend upon being able to remedy construction faults by the use of asphaltic or oil applications.

10. *Keeping up to date on standard Bureau plans and specifications.*—Those made only a year ago are very likely to contain changes which are vital. District engineers should insist on having the latest edition of all plans and specifications.

11. *Nurseries.*—Certain fruit-bearing trees, when planted on the roadsides, may be depended upon to produce a revenue which will form an appreciable addition to the maintenance funds. Pili nut and biao (lumbang oil) nut trees bear fruit in from one to two years, and the product has a high market value. Mangoes are long in coming to bearing, but the revenue from a single tree has run as high as ₱300 a year. Coconut trees are liable to prove dangerous because of falling nuts. Tree cotton, or kapok, being a non-absorbent material, is gradually coming into greater demand for life preservers. The tree is not pretty, but grows very thickly. Ilang-ilang ought to prove successful in some sections.

12. *Esthetics.*—A small increase in the cost of a road will often give a dustless road, which should mean the saving of many lives from consumption and kindred diseases, the germs of which propagate in the dust from these unsanitary highways. Tree planting has already been mentioned, and tree surgery may often be applied to existing trees with good effect. The tasteful embellishment of bridges, culverts, signposts, embankments, etc., costs but little, and should not be overlooked.

An interesting experience in the relocation of an old road was reported from Pampanga, where 18 curves were eliminated in a distance of 1,180 meters. In this instance the distance saved made it economical to purchase the land for the new right of way.

## ROAD MAINTENANCE.

Committee.—Morrison, West, R. L. Barry, Baluyot, Segura.

The present system of isolated caminero maintenance for first-class roads was indorsed by practically every member of the conference, although two or three of the engineers would modify it so that grasscutting, shaping up of subgrade, and cleaning out of ditches should be done at stated periods during the year by separate gangs. The majority of opinions expressed recognized both the esthetic and the utilitarian value of maintaining sodded shoulders and slopes, the grass to be kept short and neatly trimmed.

Recommendations as to sizes of maintenance material varied considerably. For general maintenance, however, such as filling shallow ruts, correcting slight unevennesses in the road surface, etc., the  $\frac{1}{2}$ -inch and  $\frac{3}{4}$ -inch sizes are generally preferred, for both gravel and broken stone. To produce these sizes with hand screening, it was agreed that 1-inch and  $1\frac{1}{4}$ -inch screens, respectively, should be employed.

The following definition was drafted by a special committee and adopted by the conference: "Maintenance of designated first-class roads is the act of preserving such roads without deterioration. A gradual uniform wearing down of the surfacing, the minimum consistent with economy, shall be allowed to take place. Maintenance shall include resurfacing whenever the old surfacing shall have become worn so thin that it is unable to carry the traffic."

## FLOORS FOR STEEL BRIDGES.

Committee.—McGlathery, Sjoval, Canaga.

The discussion turned for the most part upon the advisability of using lighter floors for steel bridges, under certain conditions, than the concrete and macadam which has been generally specified heretofore. It was admitted that cement concrete floors for city bridges were practically essential on account of the excessive vibration to be withstood; but that for bridges in or near country towns, carrying moderate traffic, the wood floor provides the necessary strength, while the vibration can be largely taken care of by a layer of bituminous concrete over the floor planks, or by longitudinal plank runways. Wood blocks, for use over concrete floors, were recommended by one of the speakers as being lighter than macadam, either untreated ipil blocks or creosoted lauan or apitong. Sheet asphalt was also mentioned in this connection.

The following tabulation gives the weights per square foot of the various kinds of flooring, and the estimated effects these weights would have on the weight of steel required and also on the cost of the bridge.

Class of flooring.	Weight of floor per square foot.	Weight of steel.	Cost of bridge.
	Pounds.	Per cent.	Per cent.
(a) For city bridges:			
1. Concrete floor with 4-inch wood block pavement	100	90	100
2. Concrete floor with 4-inch bituminous macadam surfacing	120	95	100
3. Concrete floor with 2-inch sheet asphalt pavement	105	90	95
4. Concrete floor with water-bound macadam surfacing	135	100	100
(b) For bridges in or near towns and on through roads:			
1. 3-inch plank floor with 2-inch running boards	16	70	75
2. 3-inch plank floor with 4-inch bituminous concrete pavement	60	80	85
(c) For feeder roads, light traffic: 3-inch plank floor	14	70	75

Percentages given are from preliminary calculations and are approximate only. Width of roadway assumed constant. First cost only considered.

The following resolutions were adopted by the Conference:

Whereas, it is believed that better results can be obtained by making certain changes in the types of floors for steel bridges;

Be it resolved to recommend the following:

(a) That the use of cement concrete floors be discontinued, except on heavy traffic city bridges.

(b) That present timber floors on steel bridges, in or near large towns, and on principal through roads, be provided with hardwood runways, 60 centimeters wide, 1.50 meters on centers, made of 2-inch planks run longitudinally of the bridge, and that where the width of the bridge is such as to permit a double line of traffic, two sets of such runways be laid, 2.60 meters on centers.

(c) That one or more experimental floors, consisting of hardwood planks with a 10-centimeter depth of wearing surface of bituminous macadam, be built as soon as possible with a view to the use of these floors on steel bridges in or near large towns and on principal through roads.

(d) That only plank floors, with or without hardwood runways, be used on steel bridges on feeder roads.

(e) That reports on timber floors of steel bridges, giving date laid, kind of wood, cost, date of inspection and condition as to rot, wear, damage by any, etc., be made by the highway engineer, a sufficient number of examples being chosen to give conclusive information as to the relative value of the different woods in use.

(f) That all city bridges, bridges in or near large towns, and those on through roads be made of sufficient width for at least two lines of traffic.

(g) That the question as to whether bridges on feeder roads shall be built of sufficient width to accommodate two lines of traffic, or only one, be left an open one.

Of the three kinds of wood now in use as flooring on the Quingua Bridge, Bulacan Province—ipil, yacal, and montol—it was said that ipil has not shown up as satisfactorily as was expected, but that montol has done better than was expected. At present the yacal planks are in the best condition.

## REINFORCED-CONCRETE PILE BRIDGES.

Committee.—Clark, Boggess, Morrison, James, Harrison, Vallarta.

The experiences related by the different speakers revealed the fact that concrete piles can be driven with almost any kind of driving outfit that can be put together, in some cases even without a hammer, but that the outfits which have been generally used in the past have proved uneconomical, because too light. Hence, the following general specifications for an adequate pile-driving outfit were recommended by the resolutions committee and adopted by the conference:

The pile driver should be of Oregon pine or steel, with leads about 45 feet long. The hammer should weigh not less than 4,000 pounds, and in general a heavier hammer is desirable. The hoisting engine and boiler should be of the Lidgerwood type and of at least 30 horsepower. The pumping outfit should be capable of delivering 500 gallons per minute at 150 pounds nozzle pressure, and should have separate boiler, as portability is desired.

It was further

Resolved, (1) That the designing engineer should be directed to prepare a design for a better driving cap than the one ordinarily in use, and also specifications covering the filling of these caps.

(2) That all piles should be cast the full length of the longitudinal reinforcing bars.

Mr. Clark, speaking of experiences in Leyte, described a rather novel layout of machinery: "The engine and boiler were placed on the bank separate from the pile driver, thus permitting the moving of the driver with less work, cost, and time than if the weight of the engine and boiler had to be moved. The power plant remained at one location during the construction of each bridge, the cables being led through snatch blocks so as to obtain a direct pull."

Various materials were named as having been used as cushions between the follower and the head of the pile, such as rope, rubber from worn-out automobile tires, coconut fiber, sand, etc. Duñgon was mentioned as among the best woods for use as follower, and it was proposed to place a diaphragm in the sand cap to counteract the tendency of the latter to bulge under the blows of the hammer.

For driving in hard clay it was recommended that a hole be made by driving in a 12 by 12 inch timber and then withdrawing same.

Under ordinary conditions, 4 or 5 concrete piles should be driven per ton of coal consumed.

The article on the driving of concrete piles by the use of explosives, printed elsewhere in this issue of THE QUARTERLY BULLETIN, was read from manuscript, and called forth a few other experiences of the same kind—enough to show that hard strata need prove no bar to the driving of concrete piles. Mr. Vallarta in Zambales, driving through a coral ledge in 4 meters of water, simply tied the dynamite cartridge with its two 2-foot lengths of fuse to the end of a bamboo pole, lighted the fuses, pushed the cartridge down the drive pipe of his drilling apparatus, and quickly withdrew the pipe. The misfires by this method were but few as compared with the method using long fuses.

## PAINTING STRUCTURAL STEEL.

Committee.—Harrison, Canaga.

The following resolutions were adopted:

Whereas the preservation of steel structures is a matter of vital importance, and

Whereas past efforts toward the protection of steel structures by means of coats of paint have not been as successful as could have been desired, be it

*Resolved*, (1) That the use of pitted steel should be prohibited by specifications.

(2) That it should be provided in standard specifications that all plates and shapes must be cleaned by sand blasting before assembling in the shops.

(3) That for shop painting, red lead should be used as at present.

(4) That for the first field painting after erection, the present practice of using either silica graphite or DeCo red and DeCo green should be continued, with a preference for the graphite because of the color contrast. Where a primer is necessary, DeCo inhibitive should be used because it is already mixed and properly proportioned.

(5) That, for maintenance painting, DeCo inhibitive primer should be used where a primer is necessary, and silica-graphite paint for second and third coats.

(6) That one or more portable sand-blast outfits for use in the field should be secured.

(7) That all bridges painted with a graphite primer should be thoroughly cleaned and repainted in accordance with standard practice.

(8) That no field painting should be done except after the most careful and thorough cleaning of the steel surfaces to be painted, and then only after four hours of sunshine on bright, warm, dry days, this latter to insure a dry surface on which to paint.

(9) That special attention should be given to workmanship and to the choice of brushes.

(10) That specifications should be drawn up for all paint materials and that tests should be made from time to time to insure that the paint materials furnished by the Bureau of Supply, especially red lead and linseed oil, conform to these specifications.

(11) That the use of tar paints should be discontinued except as required for special purposes, in which case special specifications would be prepared by the division of design, or in duly authorized tests.

(12) That the Bureau of Supply should be requested to have DeCo paints prepared so as to be free from volatile dryers such as turpentine, naphtha, etc.

(13) That where a dryer is necessary, japan dryer should be used, and that boiled oil should be used for bridge painting instead of raw oil.

(14) That a committee should be appointed by the Director to conduct a series of permeability, exposure, and economy tests for the purpose of ascertaining whether present practice in the selection of paints may be improved, and that, if possible, an allotment should be made to cover the costs of tests. It is suggested that paints for galvanized surfaces should be included in the study.

Mr. Canaga discussed the economy of the various paint formulas at present in use in the Philippines. He started with the premise that all corrosion, no matter by what theory it is accounted for, depends upon the presence of water, and therefore the ability of the paint film to prevent all moisture from coming into contact with the steel is a *sine qua non*. Great emphasis should for that reason be placed upon good workmanship in the thorough brushing out of the paint.

It is likely that not enough attention has been paid to the vehicle which forms the bulk of the paint, and upon which the imperviousness of the paint film largely depends. Boiled linseed oil should produce better results than raw, and experiments may show that China wood oil is better than either. A little spar varnish added to the vehicle improves any paint.

The presence of mill scale under the shop coat has given trouble on several bridges. Unless this has all been thoroughly removed before the shop coat is put on, there can be no adhesion of the paint to the steel, and even if no peeling takes place, corrosion remains in progress underneath the film. Apparently the only really successful method of properly removing the mill scale is by sand blasting. There are two ways of applying this process—either clean the steel thoroughly before the shop coat is applied, or else clean only such surfaces as are to come in contact either during fabrication or erection, until after erection is complete, when, with a portable outfit, the entire structure is sand-blasted and painted. With the latter method the shop coat is considered as temporary only, simply for the protection of the steel during erection. The sand-blasting process would

add about ₱7 per ton to the cost of the steel, but it ought to increase the life of the paint film by from three to five years.

The Kansas City method of coating steel with cement grout, put on with a cement gun and held by wire mesh reinforcement, came in for a slight discussion, and it was suggested that the method might prove advantageous for steel bridges over salt water.

For purposes of estimate and requisition, it is customary to assume 250 square feet of steel surface to the metric ton for light structural steel and 150 square feet to the metric ton for heavy pieces. One gallon of paint will cover, ordinarily, 500 square feet of steel surface one coat.

## DATA FOR BRIDGES AND BUILDINGS.

Committee.—Canaga, Segura, Caton, James, R. L. Barry.

It was rather generally agreed that B. P. W. Form No. 38 is sufficiently comprehensive to accommodate all the data necessary for the proper design of a bridge, provided all the questions are intelligently answered and sufficient attention is paid to the accuracy of the data collected. The following recommendations were submitted by the committee, and later adopted by the conference:

(1) That present Form No. 38 be followed in presenting data for bridges, and that for difficult crossings the map submitted be made to show the course of the stream for at least two bends or 1 kilometer above the bridge site and probably half this distance down stream, that contours be taken carefully, and that underwater contours be shown, especially at the bends of the stream.

(2) That samples of sand and gravel sufficient to make six sample cubes of class "A" concrete (1:2:4) be submitted with the bridge data, for testing purposes.

(3) That borings be shown on both plan and profile sufficient in number and depth to develop fully the formation and changes of the strata.

(4) That improvement be sought through greater accuracy, and that more attention be given in fully answering all questions.

(5) That a more adequate boring outfit be provided.

(6) That the subject of scales for maps and profiles, and also a detailed explanation of the various paragraphs of Form No. 38 be made the subject of an early circular.

(7) That permanent center-line hubs and bench marks be placed in all cases.

(8) That the consulting architect's present instructions as to the data desired for buildings be not changed.

(9) That the methods of testing building foundations be standardized and instructions for same be issued.

The importance of an accurate and comprehensive contour map for cases in which there is any possibility of bettering the bridge location by changing the location of the roads leading up to it was emphasized. Even if the location is not to be changed, the map is valuable in determining the area of waterway necessary for the bridge, since a cross-section, at any point desired, can be taken directly from the map. The contour interval should not be less than 1 meter, as a general thing.

Accuracy and completeness in the matter of borings was strongly urged, partly for the reason that contractors are practically conceded the right—they exercise it, anyway—to assume that the district engineer's reports with regard to strata are absolutely correct. Some of the engineers are careful to lay out the bridge they recommend, approximately, and to locate one or more borings on the site of each pier and abutment.

Mr. Canaga stated that concrete bridges built on a skew, unless the angle is excessive, cost but little more to construct than bridges normal to the direction of stream flow, the cost varying about as the secant of the angle of skew. Especially is this true of pile-and-girder bridges.

Photographs of the site were recommended to be sent in with the data, to enable the designing division to judge of the esthetic features of the design.

The proposed structure should be sketched in to scale on each center-line profile.

In submitting data, stream velocity should be described as "swift," "very swift," etc., rather than in feet per second.

Clearances necessary to meet drift conditions must not be overlooked.

The sand and gravel available may easily influence the type of structure chosen, or may call for a reassumption of stresses in designing.

It is better to describe the strata revealed by the borings, rather than to send in samples. Local names should not be used, but instead a complete description, using well-known English terms, should be submitted.

#### ESTIMATES.

*Committee.*—Sjovall, Bennett, Vallarta, Grosvenor.

The essential functions of the engineer's estimate, as enumerated by the different speakers, were as follows:

(a) To establish a basis of comparison by which any contractor's bid may be intelligently accepted or rejected.

(b) To make possible the intelligent planning of work, the regulation of the working force, and the judicious distribution of expenditures.

(c) To gauge the efficiency of the construction organization.

(d) To make it possible to complete the work within the time limit set by the estimate.

Accuracy in the measurement of quantities is insisted upon. In bridge or building construction this is comparatively easy, since the measurements can be scaled from plans, but on grading in road work it is more difficult. However, in level country, if a careful profile has been run over the center line of the road, if same has been carefully plotted, and then if no changes in location are made afterwards, the quantities can be estimated closely enough by scaling center heights and taking end areas from a table. For hilly country it is generally necessary to cross-section the work. The point to be kept in mind is that field measurements should be accurate within the limits definitely set, and not simply guessed at.

An estimate should be simply honest—neither liberal nor low. One speaker even went so far as to say that it is just as reprehensible for an engineer to be able to effect a great "saving" by completing a job considerably under his estimate as it is to have made his estimate too low.

The papers and discussions revealed a considerable diversity of methods employed by the district engineers in making up estimates. Some estimate the actual cost of the work by administration, under normal construction conditions and taking into consideration the quantity and quality of the force which is to be available for the work, and then add a percentage of from 8 per cent to 15 per cent to cover contingencies. It is considered that labor and transportation costs ought to be the same for either contractor or engineer, but that the former can buy materials more cheaply than the latter. The margin of profit of the contractor should thus be a little more than the percentage allowed by the engineer for contingencies; hence, if a responsible contractor bids at or very near the engineer's estimate he usually gets the contract. Others estimate the actual cost of the materials on the ground and add a percentage, from 30 per cent to 45 per cent, to cover the cost of labor and contingencies. A favorite method for estimating actual cost is to calculate quantities and apply unit costs obtained from cost records of actual operations. A widely used check is by comparison of floor space, cubic contents of building, etc. On grading for road work, one of the speakers recommended that the following considerations be taken into account:

(a) Class of material encountered, such as rock, clay, loam, sand, muck, etc.; (b) character of country, as side hill, rolling country, rice paddies, etc.; (c) new work or simply shaping up an old roadbed; (d) length of haul; (e) subgrade rolled or not; (f) rainy season or dry season construction; (g) slopes riprapped or sodded; (h) traffic admitted or excluded during construction. For removing stumps, where a regular stump puller would not be obtainable, a road roller was recommended, also a hoisting engine and a species of hand windlass made by twisting a lever into a rope. The estimate for the kilometer upon which road work is to be started should be increased by the cost of moving the tools, equipment, etc., and of building the camp, toolhouse, etc.

Under current accounting regulations the value of condemned tools and equipment must be charged to the project on which used; hence, every estimate should include an item covering depreciation of plant.

#### SPECIFICATIONS.

*Committee.*—Caton, West, Morrison, Halsema.

The following changes and recommendations with regard to existing specifications were mentioned in the discussion:

The Bureau of Public Works should fabricate all steel and wrought-iron work used on its building construction jobs in its own shops, being responsible to the Purchasing Agent for the quality. The present arrangement has not proved entirely satisfactory.

Louvers should be employed in place of the solid gable ends now detailed on standard school buildings.

The long front steps on school buildings No. 7 and larger should be eliminated, two flights of short steps being substituted therefor.

Standard school buildings should be raised 60 centimeters higher above the ground than present designs allow.

Mortise lock door sets should be substituted for the rim locks now specified for schoolhouse doors.

The use of screw nails for fastening galvanized-iron roofing to the purlins was suggested in place of the strap fastenings now specified.

Corrugated galvanized iron should be used for tienda roofs in place of the flat galvanized iron now specified. The architectural reason for having the tienda roofs different from the market roofs is not apparent.

No district engineer should hesitate to suggest changes in plans or specifications to the designing division whenever he deems such changes advisable.

The gravel fill under market floors should contain 20 per cent of sand.

Work turned out under the inspection of the Bureau of Supply is sometimes faulty, due probably to the inability of that Bureau to command the services of efficient inspectors; hence, all such work should be placed under the responsible inspection of the constructing division of the Bureau of Public Works.

A standing committee consisting of Caton, Morrison, and Agcaoili, was appointed by the chair to review existing specifications and to recommend changes from time to time.

#### CONCRETE: MIXING AND PLACING AND PROPORTIONING THE AGGREGATES.

*Committee.*—Halsema, Francisco, Canaga, Kasilag.

Advance notice was given of a chart for proportioning the aggregates and the cement for constant strength, which has been designed by the designing division. The chart, however, is based upon certain theoretical considerations, the truth of which have not yet been established by experiment; hence, the matter must be held in abeyance until these experiments have been completed. In working the chart, the percentages of voids in the aggregates are to be used as arguments.

Four general methods of proportioning were cited: (1) Arbitrarily by volumes, as, 1:2:4, 1:2½:5, etc.; (2) void determinations; (3) obtaining by trial the densest mixture possible; and (4) by mechanical analysis, using sieves to separate the material of an aggregate into the various sizes of which it is composed. Method No. 3 will probably give the best results, on the assumption (by no means proved as yet) that for a given proportion of cement the densest mixture is the strongest. Method No. 4 was characterized as being too cumbersome for field use.

Some of the speakers very strongly favored a specification clause requiring all mixing to be done by means of a power-driven batch mixer, and a resolution was introduced to that effect, but the resolution failed of passage.

In the discussion regarding hand-mixing methods a number of points were emphasized, such as locating the mixing platform close to the storage piles; having the board large enough, say, 4 by 6 meters; cutting the cement barrel when a fractional batch is desired; having the concrete placed by a separate gang and not by the mixers; wages higher than normal for trained mixers; requiring the capataz to keep daily records of amount of concrete mixed, etc.

The discussion on the use of salt water for mixing was inconclusive. Several cases of failure were cited, where it was known that salt water had been used, but in practically every case the failure could probably be traced to other causes, such as poor cement, inadequate

inspection, etc. The trend of opinion seemed to be, however, that any engineer would be justified in the incurring of considerable extra expense to obtain fresh water, say, by distillation, etc.

#### UNIT CONSTRUCTION OF MARKET COLUMNS.

*Committee.*—Grosvenor, J. R. Barry, McGlathery, Boggess.

The following advantages of the system of unit construction of market columns were cited:

(a) Saving in cost, due to less false work required (not believed to be true, however, with the present type of market); smaller number of men required on construction, possibility of carrying on work under shelter during bad weather; and less time required.

(b) Less liability of shrinkage cracks developing.

(c) Better workmanship which can be obtained by casting the units separately.

(d) Possibility of making actual tests of the units before erection.

Also the following disadvantages:

(a) The difficulty of securing rigid connections between girders, beams, and columns.

(b) The impossibility of obtaining, under ordinary circumstances, as strong or as good-looking a finished structure as with monolithic construction.

(c) The heavier sections which would be required, and at times the smaller headroom to be obtained.

(d) The liability that, in setting the columns during rainy weather, lines of cleavage would be formed between the different units, which would admit moisture from the ground and ultimately result in the rusting of the reinforcing steel, thus causing the column and base to act separately.

The following resolution was adopted:

*Resolved*, That, as the saving in time and cost is doubtful, and the disadvantages apparently outweigh the advantages, the unit method of construction of market columns shall not be generally adopted until at least one building can be constructed by this method under the closest supervision and cost accounting, and it is found that the method is advantageous as regards strength, appearance, and cost.

#### CONTRACT VS. ADMINISTRATION.

*Committee.*—Agcaoili, Baugh, Sylvester, E. C. Brown.

The following resolutions, adopted by the conference, are a fair résumé of the conclusions reached in the discussion:

*Resolved*, (1) That contract work should be left optional with the district engineer whenever the work in question can be handled as economically by the district.

(2) That when bids are called for and presented, they should be judged from the standpoint of economy and also upon the ability and reliability of the contractor.

The question of whether to do a given piece of work by contract or by administration generally turns upon the possession of equipment, whenever the equipment required is extensive and costly, as it would be for driving concrete piles, erecting steel bridges, building broken-stone roads (roller, crusher, etc.). The actual work can be performed about as cheaply by one party as by the other, but the equipment can be bought and maintained profitably only by the party who is able to keep it busy. Practically every province owns an outfit of road-building machinery; but a contractor, not being restricted as to territory, ought to be able to maintain a pile-driving outfit to better advantage than a district engineer, unless the latter has a large number of concrete-pile bridges to build.

One of the chief advantages of administration work is that changes in plans and specifications may be carried out with greater facility than on contract work. This applies especially to road construction, because of the difficulty of determining natural conditions except as the work progresses. Another advantage is that the bulk of the appropriation is expended in the province among the people who pay the taxes. This same condition would obtain were the work done by local contractors, however, and it was agreed that situations might arise which would make it advisable to encourage local contractors, at first even to the extent of paying them a little more than the work would cost by administration.

Unless a contractor is not only absolutely honest, but as jealous of his reputation as a producer of good work as an engineer would be, the administration method will generally result in the better job. On the other hand, the contractor, not being restricted either in the market for his materials or in the rate of wages he pays, and being able to specialize and thus do the work with trained gangs of workmen, is often in a position to do the work not only cheaper but actually better than the district engineer. Hence, the necessity of a knowledge of the contractor's reliability before awarding him a contract, no matter how low his bid.

Some of the engineers argued that inspection could be made more effective on contract jobs than under administration, owing to the fact that the inspector would have no accounting duties to look after. It was pointed out, however, that this would be true only for large contracts or jobs located near the district engineer's headquarters. On small and remote contract jobs the amount justified for inspection is liable to be too small to command the services of a competent inspector, whereas if the job were done by administration the salaries of Government inspector and contractor's foreman could be combined for the purpose of securing a competent foreman-inspector. The integrity and ability of the contractor would also be a factor in determining the amount and character of the inspection necessary.

The "paquiao" system of small contracts, usually verbal or at most supported only by a simple memorandum of agreement, is used and was recommended by practically every district engineer present, and was not considered as a contract system within the meaning of the term under discussion.

Regarding the question as to whether a district engineer should be held financially responsible for failure to complete a job within his estimate, the general opinion was rather happily expressed as follows by Mr. Sjoval:

The district engineer's estimate bears the same relation to the final cost of the work that the physician's diagnosis of a case bears to the recovery of his patient or the general's plans bear to the outcome of a campaign. None of these has ever been made the subject of a guaranty. Only if engineers are afforded some kind of insurance to cover failure of estimates can they afford to guarantee them, and this insurance they get when they enter the contractor class and enjoy the profits.

#### ENGINEERING RELATIONS BETWEEN CONTRACTOR AND ENGINEER.

*Committee.*—J. R. Barry, Gomez, Austin, Caton, Scheidemantel, Bennett.

The following quotations from papers and discussions will serve to show the trend of opinion of the conference:

The district engineer's endeavor should be to get the maximum quantity and quality of work accomplished along the lines of least resistance.

After the contract is awarded, the district engineer should assist the successful bidder to make money on the project. Every extra peso made by the contractor means that much saved by the Government on the next job. The engineer's first duty is, of course, to see that the Government's interests are protected, but after that he should help the contractor where possible.

On bridge work the inspector should be an engineer or at least a man with sufficient technical education to understand fully the importance of various clauses in the specifications. A ₱40 inspector cannot properly inspect the work done by a ₱300 contractor's foreman.

Proper relations can at once be established by considering the contractor as nothing more than an employee of the engineer while engaged on contract work under the latter's supervision.

The engineer should never forget that the contractor is entitled to the same privileges that he himself would take were the work done by administration.

Inspection should in all cases be the best obtainable—not necessarily the cheapest.

#### RIGHT OF WAY.

*Committee.*—Russell, Sylvester, Smith, Francisco.

Almost all of the papers and discussions recommended the 15-meter right of way for first-class roads. A few raised the question of keeping the grass cut over the portion which would fall outside the ditches, but it was pointed out that in any but the lightest possible construction, 15 meters is none too much for the 7-meter shoulder width usually demanded, and the flat side slopes and shallow ditches. Exceptions were recommended in the case of cuts where the slopes



would stand nearly vertical, but it was recognized that these isolated cases should not be allowed to affect the general principle.

There was also a noticeable trend in the discussions to accept the 15-meter width as the minimum only, and to advocate widths of 16 to 18 meters where there was likely to be great development of swift automobile traffic.

Very few of the engineers are paying outright for the land necessary to widen old roads, and but few more on new locations. By carefully explaining the natural benefits of roads, and by other means of coöperating with the people, less and less right of way troubles are being reported. Payment in full for damages done to growing crops and for the moving of houses, fences, etc., is practically always offered, and in most cases satisfies the landowner, especially as it is a well-recognized fact that the Filipinos display a liberal public spiritedness in right of way matters to which the average American farmer is a stranger.

Mr. Miguel Unson, treasurer of Pampanga, presented by letter the following draft of a bill designed to simplify the problem by legally prescribing its limits and possibilities:

An Act providing that the cost of land necessary for widening the roads shall be assessed against the adjoining property.

*By authority of the United States, be it enacted by the Philippine Legislature, that:*

SECTION 1. Whenever a first-class road is constructed and it will be convenient to widen it to the standard section of fifteen meters, the provincial board of the corresponding province shall order such improvement executed by the district engineer, and shall assess the cost of acquiring the necessary land against the adjoining property. The amount thus assessed shall be collected in the same manner and in the same period as provided for land taxes.

SEC. 2. The amount to be assessed shall include only the actual cost of the land taken with the damages, losses, and costs paid, but shall include no claim for improvements made thereon, engineering expenses, and Bureau of Public Works' charges, nor shall it include the expenses for the construction of road.

SEC. 3. The assessment shall be made proportionate to the lineal meters of the private property adjoining the road thus widened, and shall be made by sections; urban, suburban, barrio, and rural; and by subsections which the provincial board may deem necessary, it being the purpose of such assessment to make a fair apportionment of the cost of the land paid for in widening the road to the adjoining property receiving the immediate benefit of such improvement.

SEC. 4. This Act shall take effect upon its passage.

Enacted, ..... 19.....

Mr. Unson proposes the bill merely as the adaptation to Philippine road conditions of a system of right of way assessments now in force in at least 36 American cities. The conference accorded Mr. Unson a vote of thanks.

Several of the engineers described methods of "clinch" the landowner's consent in some form of written agreement. In some cases the receipt for money paid as indemnification for damages done to growing crops is so worded as to convey to the Government the right to enter and build and maintain the road, though not necessarily to constitute a Torrens title to the land. Sometimes each farmer is asked to sign a quit-claim deed to his part of the right of way. A method just coming into use is a regular "memorandum of agreement" form, signed by the landowner, the district engineer, and two witnesses, in which the landowner guarantees the Government's right to build and maintain the road and also the public's right to use it, and in which the district engineer covenants to bear all the expense of moving houses, fences, etc. In some provinces coconut and other fruit-bearing trees are left standing on the shoulders of the road, the trees and their usufruct remaining the property of the farmer. It was pretty generally admitted that, while the particular "clinch" used is relatively unimportant, the value to the Government, in later right of way controversies, of some form of written agreement is not to be doubted.

The following resolutions were passed:

*Resolved*, (1) That only such a width of right of way on trails and third-class roads as is actually needed shall, for the present, be taken.

2. That the title to the right of way for new roads through settled

country, and for diversions from old roads, should be definitely acquired, by purchase or otherwise.

3. That the right of way for development roads through new country, and for reconstruction of old roads in developed country, should be definitely acquired but not paid for; but that reimbursement should be made for crops and trees destroyed and for improvements removed.

RELATIONS WITH LOCAL AUTHORITIES, SURCHARGES, AUTHORIZED PERSONNEL, PROVINCIAL ENGINEER VS. DISTRICT ENGINEER, ETC.

*Committee.*—Westerhouse, Cameron, Smith, Russell, Glenn, L. R. Brown, Kasilag, Ines, Baluyot.

Intelligent, careful explanation should be the keynote in all dealings with local authorities. The distribution of public funds is determined by the provincial boards and municipal councils, and they are entitled to as much information, both technical and otherwise, as they need in order to enable them to make these distributions to best advantage. District engineers should make it a point to be present at all provincial board meetings when engineering matters are to be passed upon, and should always back up their recommendations by full and complete explanations.

The question of surcharges was discussed at some length. It was pointed out that the official most concerned in fixing the rate of surcharge, and also most competent to do it, is the district engineer, and that in nearly every case where he takes the initiative, supporting his recommendation by detailed estimates of disbursements and engineering expenses, the district auditor and provincial treasurer will be glad to accept it. The new Auditor's circular is expected to remedy the considerable nonuniformity which has existed heretofore in provincial rates of surcharge, by making that surcharge cover only the travelling expenses of the district engineer, the total clerical expense of the district office, the salaries and expenses of those Bureau of Public Works technical employees whose names are listed on the monthly personnel list of the constructing division, and no more.

A special committee, consisting of Russell, Harrison, Grosvenor, Baluyot, and Segura, was appointed to draft a maximum salary list for the clerical employees of the district offices. The committee presented the following scheme, which, however, failed of adoption in the conference:

*District office personnel salaries for usual conditions.*

Designation.	Class of province.				
	First.	Second.	Third.	Fourth.	Fifth.
Chief clerk.....	P1,440	P1,320	P1,200	P960	P720
Other office clerks.....	2,160	1,320	600	480	360
Total to be approved by the Bureau of Public Works without question.....	3,600	2,640	1,800	1,440	1,080
WHEN EXTRA WORK DEMANDS.					
Extra by approval of the Director.....	1,020	840	600	360	360
Total (when conditions require).....	4,620	3,480	2,400	1,800	1,440

\* Amendment adopted before the main scheme came to a vote substituted P2,400 in place of P1,800.

Temporary clerks in excess of the above to be by authority of the Director when necessary.

Maximum salaries named for chief clerks may not be exceeded, but no objection to be raised where salaries in excess of these sums are now being paid.

Draftsmen and paymasters in excess of the above-provided "plan-tilla" if approved by the Director, but when employed, if used a portion of the time on clerical work, the proportion of time so used must be charged against the regular office allowance.

In reviewing the provincial engineer bill passed by the Philippine Assembly at its last session, it was noted with satisfaction that this bill is far less radical than any of its predecessors, due without doubt to the growing sentiment throughout the engineering world that centralization is much better than decentralization for the prosecution of public works, and especially of highway construction and maintenance. The principal objections to the bill are: (1) Insecurity of the provincial engineer's tenure of office, making it extremely difficult to retain the services of competent men; (2)



possible demoralization of the provincial engineer's technical and office force through political influence with every change in the provincial government; (3) useless expense of maintaining a costly designing force in every provincial office, practically impossible for the smaller provinces; and (4) the detailed control over technical features of the work which this bill would inevitably place in the hands of an organization composed entirely of laymen.

# LICENSING OF CIVIL ENGINEERS.

Committee.—Gordon, Kasilag, Ageaoili, Russell, Harrison, Cameron, Ines, L. R. Brown.

The following resolutions were adopted:

Whereas, it is the opinion of this conference that the licensing of engineers produces neither gain to the public nor any additional safeguard against the loss of life and property, and

Whereas, the licensing of engineers will not determine the judgment, the executive ability, the character, nor the fitness of the licensees, it is hereby

Resolved, (1) That the licensing of engineers is contrary to the best interests of engineers.

(2) That in case the licensing of engineers is insisted upon, it is recommended that the Director appoint a committee of three to draft a "Licensing Act."

The subject was discussed under two general heads: (a) Benefits to the engineers themselves, and (b) benefits to the public in the way of guaranties as to the safety of structures. It was pointed out that inasmuch as the majority of the engineers in the Philipnpes are in the Government service, it would be only a minority that could possibly be benefitted by a licensing system. As to the second point, the practice of some cities of the United States was cited, wherein every design made by an engineer in private practice has to be passed upon by a Government inspector, and in many cases the actual construction must be supervised by the Government. Practically all the machinery needed for putting this scheme into operation in the Philippines is already in existence in the Manila city engineer department and the district organizations of the provinces.

It was agreed that examinations should accord rather more weight to experience, and especially to experience in responsible positions, than to mere scholastic attainments.

Two arguments in favor of licensing were cited; the first, that it would eliminate a number of "fake" engineers, as one speaker put it, *maestros de obras*, etc., who at present are enabled to foist inferior designs upon the public. The second argument is that, being only one Government here, any license issued would be good anywhere in the Islands.

The difficulty of securing the services of a competent and comprehensive board of examiners, and also the great expense of maintaining such a board, were touched upon, likewise the difficulty of keeping the entire scheme free from invidious political influences.

# MISCELLANEOUS.

Secretary Riggs paid the conference a short visit on Monday, February 15, and spoke very encouragingly of the financial outlook for public works in the Islands during the coming year. He and Mrs. Riggs gave a reception for the members of the conference and their ladies on Saturday, February 13.

Votes of thanks were unanimously accorded to the Baguio Country Club for hospitality in entertaining the conference, to the mayor of Baguio for his efficiency in handling the various inspection trips, and to the officials responsible for this year's decision to hold the conference in Baguio in the following final resolution:

Whereas, it is the unanimous conviction of the personnel of this conference that a better exchange of ideas has been accomplished and better results obtained than in any previous conference, and

Whereas, the change in scene, climate, and environment has been

greatly conducive to the superiority of this conference over all those in the past, it is hereby

Resolved, That the officials responsible for the holding of this conference in Baguio be hereby apprised of the unanimously appreciatory sentiment existing, and of the unanimous recognition of the excellence of this conference.

The conference adjourned *sine die* on February 16, 1915, at noon.

# FINANCIAL.

## APPROPRIATIONS AND ALLOTMENTS FOR ROADS AND BRIDGES FOR THE FISCAL YEAR 1915 DISTRIBUTED ON A POPULATION BASIS, APPROVED AND ALLOTTED.

### REGULAR ALLOTMENTS UNDER ACT NO. 2494.

Albay .....	₱50,297.00
Ambos Camarines .....	50,173.00
Antique .....	27,985.00
Bataan .....	9,636.00
Batanes .....	1,552.00
Batangas .....	53,930.00
Bohol .....	56,347.00
Bulacan .....	46,796.00
Cagayan .....	28,062.00
Capiz .....	59,152.00
Cavite .....	28,114.00
Cebu .....	137,091.00
Ilocos Norte .....	37,399.00
Ilocos Sur .....	48,154.00
Iloilo .....	85,976.00
Isabela .....	14,257.00
Laguna .....	31,018.00
La Union .....	25,965.00
Leyte .....	81,484.00
Mindanao and Sulu .....	96,016.00
Misamis .....	27,657.00
Nueva Ecija .....	27,981.00
Occidental Negros .....	64,547.00
Oriental Negros .....	42,124.00
Palawan .....	7,307.00
Pampanga .....	46,799.00
Pangasinan .....	92,740.00
Rizal .....	31,504.00
Samar .....	55,720.00
Sorsogon .....	34,286.00
Surigao .....	16,634.00
Tarlac .....	28,183.00
Tayabas .....	42,718.00
Zambales .....	12,396.00
Total .....	1,500,000.00

### SPECIAL ALLOTMENTS UNDER ACT NO. 1988.

Occidental Negros .....	75,000.00
Pampanga .....	90,000.00
Tarlac .....	25,000.00
Leyte .....	30,000.00
Cagayan .....	25,000.00
Mindanao .....	30,000.00
Ambos Camarines .....	15,000.00
Misamis .....	10,000.00
Total .....	300,000.00

*Appropriations and allotments for roads and bridges for the fiscal year 1915 distributed on a population basis, approved and allotted—Continued.*

## SPECIAL ALLOTMENTS UNDER ACT NO. 1988.

Batangas .....	₱55,000.00
Cavite .....	35,000.00
Ilocos Sur .....	35,000.00
Laguna .....	105,000.00
La Union .....	33,000.00
Nueva Ecija .....	50,000.00
Pangasinan .....	45,000.00
Rizal .....	55,000.00
Tayabas .....	30,000.00
<b>Total .....</b>	<b>443,000.00</b>

**LOANS FOR ROADS, BRIDGES, SCHOOLS, MARKETS, ETC.,  
FROM JANUARY 1, 1915, TO MARCH 31, 1915.**

Province and project.	Act Nos.		
	1729.	2083.	Total.
Albay: Quinali Bridge .....		₱25,000.00	₱25,000.00
Ambos Camarines: Iriga Central School .....		10,000.00	10,000.00
Batangas:			
Lemery market .....	₱12,000.00		12,000.00
For purchase of cemetery site, Lipa .....	5,000.00		5,000.00
Matayuanac, Kaytitinga, and Palico Bridges on the Tuy-Nasugbu Road .....		165,000.00	165,000.00
Bulacan:			
Pulilan market .....	12,000.00		12,000.00
Paombong Central School .....		3,500.00	3,500.00
Cagayan: Babogan Bridge .....		50,000.00	50,000.00
Cavite: Cavite market and retaining wall .....	6,000.00		6,000.00
Ilocos Norte:			
Badoc market .....		12,000.00	12,000.00
Bacarra market .....		12,000.00	12,000.00
Badoc School .....	3,000.00		3,000.00
La Union: Bauang market .....		12,000.00	12,000.00
Leyte:			
Ormoc market .....		20,000.00	20,000.00
Hilongos market .....		12,000.00	12,000.00
Manila: For the construction of a bulkhead on the water- front between piers 3 and 5, Manila Bay .....		210,000.00	210,000.00
Nueva Ecija:			
Cuyapo market .....	20,000.00		20,000.00
Peñaranda market .....		8,000.00	8,000.00
Pangasinan: Rosales market .....	4,000.00		4,000.00
Rizal: Navotas market .....		15,000.00	15,000.00
Sorsogon: Bacon market .....		10,000.00	10,000.00
Tayabas: Tayabas-Luchan Road .....	23,000.00		23,000.00
<b>Total .....</b>	<b>85,000.00</b>	<b>564,500.00</b>	<b>650,000.00</b>

## SELECTED.

## TOO TECHNICAL.

One time a man came out of college  
 An engineer and full of knowledge  
 Plus, how to solve all problems truly—  
 The lemniscate of James Bernouilli—  
 The spiral screw of Archimedes—  
 (But not where the best place to feed is.)  
 With ease could circumscribe the rector;  
 With ease bisect the radius vector.  
 He used not lunar time, but solar,  
 Observing stars, (the circumpolar),  
 Expecting to locate an heiress  
 By observations of Polaris  
 And thought that love from a surveyor  
 Could be transported by conveyor.  
 Not quite so base as perpendicular—  
 To raise himself by means funicular.  
 When he appeared at any function  
 Intending to effect a junction,  
 (Though not a cad from old Acadia),  
 He measured life too much by stadia.  
 He older grew and grew one-sided  
 Just like a pear when subdivided;  
 Or, like the leaning tower of Pisa  
 Referred to by Tiglath—Pileser.  
 The thought of other occupations  
 Did not appear in calculations.  
 For logarithms exponential  
 His interest was differential,  
 While problems of the fourth dimension  
 Absorbed too much of his attention.  
 A man whose rating is a million  
 Required lines for his pavilion  
 And, lo! this man from Narragansett  
 Did not know how to use a transit.  
 The moral, as you have inferred,  
 Obtained when this event occurred.

—Percy G. Smith, C. E.

# APPENDIX C.

## PROJECTS ACTIVE JANUARY 1, 1915.

Provinces.	Roads and trails.				Bridges and culverts.				Provincial administration buildings.			Municipal administration buildings.			Prisons.			Schools.				Construction and operation.												
	Construction.	Maintenance.	Repair.	Reconstruction.	Construction.	Maintenance.	Repair.	Reconstruction.	Construction.	Maintenance.	Repair and alteration.	Construction.	Reconstruction.	Maintenance.	Construction.	Repair and alteration.	Maintenance.	Construction.	Maintenance.	Repair and alteration.	Reconstruction.	Markets.	Parks, grounds, and athletic fields.	Miscellaneous buildings.	Ferries.	Water systems.	Record vaults.	Quarries.	Telephone lines.	Electric-light plants.	Miscellaneous.	Total.		
Albay	3	2			3					1								4	1			2		1							2	19		
Ambos Camarines	13	8		3	4	1												2				3	1	2								37		
Antique	4	2			3													1														12		
Bataan	2	3		3	1																											11		
Batangas	6	5			2	1		1		1	1	1				1		8	2		3	3	2	4		3						46		
Bohol	1	3		1	4																											10		
Bulacan	3	3																														9		
Cagayan	2	4			1	1				1		1				1		1	2						1							5	20	
Capiz	3	3		1	1					1								4	1						1							1	17	
Cavite	4	2			1													4															11	
Cebu	7	2	1		1	1												1						2		1						5	23	
Ilocos Norte	2	1			1			1			1							5				2											13	
Ilocos Sur	14	3	1		3	1							2					13				1	1	1	2	1	1					3	45	
Iloilo	5	4	2		1		2											1		1		2	1			1						4	23	
Isabela	3	4			2	1												1		1				2									14	
Laguna	1	2	2		2			1										13	1	1		1	2		1	1			1				27	
La Union	7	4			3													6				3	1		1								26	
Leyte	1	2			11													3															18	
Misamis	3	3			2													1													1		10	
Nueva Ecija	3	2			1													6				2	1		1								17	
Occidental Negros	11	2			4													1				2	1		1								22	
Oriental Negros	3	4			2					1								5				3				2							3	23
Pampanga	2	3			1											1		4				8		1									1	20
Pangasinan	5	3		1	5							2	2	1				3					1		2								3	28
Rizal	2	6	1		2	1				1								2	1			1		6									1	25
Samar	3	4			1													5				1	1										3	18
Sorsogon	2	2			3													2															5	14
Surigao	2	2																4		3														11
Tarlac	1	3										1						2				1											2	10
Tayabas	2	3			1					1								3				4	1	1										16
Zambales		2			11													1															1	15
Total	118	97	7	9	77	7	2	3		7	2	5	5	1		3	1	106	9	4	3	43	13	19	9	9			1	1	49	610		

NOTE.—The 49 projects under the caption "Miscellaneous" represent 17 surveys and investigations of roads, bridges, water systems, etc., 3 dikes, 3 wharves, 2 harbor maintenance, 1 irrigation system, 1 auto line, 1 monument, etc.

# BUREAU OF PUBLIC WORKS

## ORGANIZATION

**WARWICK GREENE**, *Director of Public Works*

**G. C. FENHAGEN**, *Consulting Architect*

**G. G. STROEBE**, *Acting Chief Designing Engineer*

**H. F. CAMERON**, *Senior Supervising Engineer, Mindanao and Sulu*

**C. LINDSEY**, *Assistant to the Director*

**WILLIAM HIRZEL**, *Chief Accountant*

**O. K. OLESON**, *Property Clerk*

**L. L. COOK**, *Superintendent of Automobiles*

**JOSE VENTANILLA**, *Record Clerk*

## CONSTRUCTING DIVISION

**E. J. WESTERHOUSE** (Absent), *Chief Constructing Engineer*

**C. E. GORDON**, *Highway Engineer (Acting Chief Constructing Engineer)*

**D. E. HENRY** (Absent), *Senior Supervising Engineer*

**J. W. VICKERS**, *Superintendent of Artesian Wells*

## DISTRICT ENGINEERS

Brown, E. C.....	Albay, Albay	Barry, J. R.....	Los Baños, Laguna
Dandois, Chas. S.....	Naga, Ambos Camarines	Clark, L. T.....	Tacloban, Leyte
Segura, Valeriano.....	San Jose, Antique	Ines, Leon.....	Dansalan, Lanao
Williams, A. D.....	Baguio, Benguet	Caton, J. H. 3rd.....	Manila
Francisco, Luis.....	Balanga, Bataan	Scheidemantel, L. W..	Cagayan, Misamis
Cookingham, J. C.....	Batangas, Batangas	Austin, A. W.....	Cabanatuan, Nueva Ecija
Harrison, J. L.....	Malolos, Bulacan	McGlathery, S. L.....	Bacolod, Occidental Negros
Bogges, L. S.....	Tagbilaran, Bohol	Grosvenor, I. R.....	Dumaguete, Oriental Negros
Barry, R. L.....	Tuguegarao, Cagayan	Halsema, E. J.....	San Fernando, Pampanga
Bennett, C. R.....	Cavite, Cavite	Morrison, C. G.....	Lingayen, Pangasinan
Sjovall, A. H.....	Capiz, Capiz	Brown, L. R.....	Pasig, Rizal
Russell, Claud.....	Cebu, Cebu	Baugh, N. R.....	Catbalogan, Samar
Klise, R. D.....	Cotabato, Cotabato	Lilley, H. B.....	Sorsogon, Sorsogon
Manuel, Antonio.....	Davao, Davao	Meehleib, H. R.....	Surigao, Surigao
Glenn, R. V.....	Iloilo, Iloilo	Schenk, E. E.....	Jolo, Sulu
Baluyot, Sotero.....	Laoag, Ilocos Norte	Agcaoili, Romarico...	Tarlac, Tarlac
Smith, E. D.....	Vigan, Ilocos Sur	Sylvester, A. T.....	Lucena, Tayabas
Gomez, Pastor.....	Ilagan, Isabela	Vallarta, Julian.....	Iba, Zambales
Kasilag, Marcial.....	San Fernando, La Union	Yankey, A. G.....	Zamboanga, Zamboanga